

**CERATIUM SCHRANK (DINOPHYCEAE) OF THE NATIONAL PARK
SISTEMA ARRECIFAL VERACRUZANO, GULF OF MEXICO, WITH A
KEY FOR IDENTIFICATION**

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ABSTRACT

The morphology of 33 species of *Ceratium* (38 including infraspecific taxa) was studied based on about 600 phytoplankton 20- μ m net samples taken from May 2005 through March 2008 at eight sampling stations in the northwestern part of the National Park Sistema Arrecifal Veracruzano, southern Gulf of Mexico. Short descriptions and synonyms are given for each species. Cell size variation with the mean and the standard deviation are given for most species. Twenty-three species are provided with affinities and taxonomic, nomenclatural or biogeographic comments. A dichotomous key for identification of all the species found is presented, and species are illustrated with light microscope photographs and line drawings. *Ceratium dens*, *C. bigelowii*, *C. limulus*, *C. tripos* f. *tripodoides* and *C. declinatum* var. *angusticornum* are new records for the Mexican waters of the Gulf of Mexico.

Key words: *Ceratium*, dinoflagellates, Gulf of Mexico, key for identification, taxonomy.

RESUMEN

Se estudió la morfología de 33 especies de *Ceratium* (38 incluso los taxa infraespecíficos) con base en aproximadamente 600 muestras de red (20 μ m) tomadas de mayo de 2005 a marzo de 2008 en ocho estaciones de muestreo en el sector noroeste del Parque Nacional Sistema Arrecifal Veracruzano, la parte sur del Golfo de México. Para cada especie se dan descripciones cortas, así como la sinonimia. La variación de tamaño

de las células, el promedio y la desviación estándar se presentan para la mayoría de las especies. Para 23 taxa se proporcionan notas sobre sus afinidades, al igual que comentarios taxonómicos, nomenclaturales y biogeográficos. Se incluye una clave dicotómica para la identificación, así como las fotografías en microscopio fotónico y dibujos a línea de todas las especies encontradas. *Ceratium dens*, *C. bigelowii*, *C. limulus*, *C. tripos* f. *tripodooides* y *C. declinatum* var. *angusticornum* son nuevos registros para la parte mexicana del Golfo de México.

Palabras clave: *Ceratium*, clave para identificación, dinoflagelados, Golfo de México, taxonomía.

INTRODUCTION

The genus *Ceratium* is one of the most common and widespread in marine phytoplankton, along with the genus *Protoperidinium* Bergh. In the southern Gulf of Mexico, 13 of the 28 most common dinoflagellate species belong to the genus *Ceratium* (Licea et al., 2004). Similarly, in the northern Gulf of Mexico, 13 *Ceratium* species were among the 30 most common (Balech, 1967). Due to the larger cell size of *Ceratium* species and their relatively well-known latitudinal geographic distributions, in many cases rather well delimited (Dodge, 1993; Dodge & Marshall, 1994), they have been used as biological indicators of water masses and currents (Frost & Wilson, 1938; Graham, 1941; Okolodkov, 1996). *Ceratium* has been suggested as an excellent, if not the best, dinoflagellate genus to use for biogeographic study and as a tool for defining ocean currents and temperature ranges and may be valuable in studies of global change (Dodge & Marshall, 1994). In the Gulf of Mexico, 70 *Ceratium* species (97 together with infraspecific taxa) have been recorded (Steidinger et al., 2009).

The taxonomy of *Ceratium* has remained extraordinarily stable since the end of the 19th century in spite of many important contributions to the morphology and systematics of this genus. Most *Ceratium* species have three horns; some have two. Recently a species with only one horn, the apical one, was described from a lake (Temponeras et al., 2000). Sournia (1986) clearly indicated the difference between freshwater and marine species based on the number of cingular plates. However, using genetic molecular analysis the genus was split into two, and a new genus designated as *Neoceratium* F. Gómez, D. Moreira et P. López-García for all known marine species (Gómez et al., 2010) was proposed. Traditionally, identification of

species and infraspecific taxa within this genus is based on the shape of the cell and its parts (mainly antapical horns) in ventral or dorsal view and some other features of the theca usually shared by a group of species. This is the approach followed here in describing species belonging to the genus *Ceratium* according to Sournia (1986).

In the State of Veracruz some *Ceratium* species have been reported (Ochoa-Figueroa, 1978; Avendaño-Sánchez & Sotomayor Navarro, 1982; Echeverría-Valencia, 1983; Hernández-Mendiola, 1988; Suchil-Vilchis, 1990; Guerra-Martínez & Lara-Villa, 1996; Zamudio-Resendiz, 1998; Aquino-Cruz, 2002; García-Reséndiz, 2003; Legaría-Moreno, 2003; Estradas-Romero, 2004; Tejeda-Hernández, 2005). Zamudio-Resendiz (1998) mentioned 22 *Ceratium* species; however, she did not give separate species lists for the State of Tamaulipas and the State of Veracruz. Nevertheless, her data are considered in the present article as all them were for Veracruz. The only study (an MSc thesis) focused on the genus *Ceratium* in both Veracruz waters and the southern Gulf of Mexico was by Figueroa-Torres (1990). It includes numerous line drawings and photographs of 35 *Ceratium* species and infraspecific taxa found during three oceanographic cruises encompassing a month in general (18°15'-19°49' N, 93°39'-95°48' W).

To document *Ceratium* species found in the National Park Sistema Arrecifal Veracruzano (NPSAV) and to provide a key for their identification were the goals of the present study.

MATERIAL AND METHODS

Phytoplankton samples were taken weekly with a hand net, 20 µm mesh and 30 cm mouth, from eight sites (stations) around the Aquarium of Veracruz in the northwestern part of the National Park Sistema Arrecifal Veracruzano. Collections were made during the period from May 2005 through March 2008 as part of the monitoring program of the Aquarium of Veracruz (Fig. 1, Table 1). Some material was taken and examined from two additional stations sampled in November-December 2007 and in March 2008 (19°02'48.1" N, 95°49'25.4" W; 19°10'26.9" N, 96°01'1.3" W). At each station the net was towed horizontally for 5 min. at the velocity of the boat of ca. 2.5 knots to sample a superficial 30-cm layer. The samples were fixed with a stock formaldehyde solution to a final concentration of 4% and stored in 100-ml dark plastic bottles. To contrast the cells for an easier search and better photographs, a 0.2% Trypan Blue water solution was added to water mounts (Lebour, 1925; Taylor, 1978). About 600 samples were analyzed using a Nikon

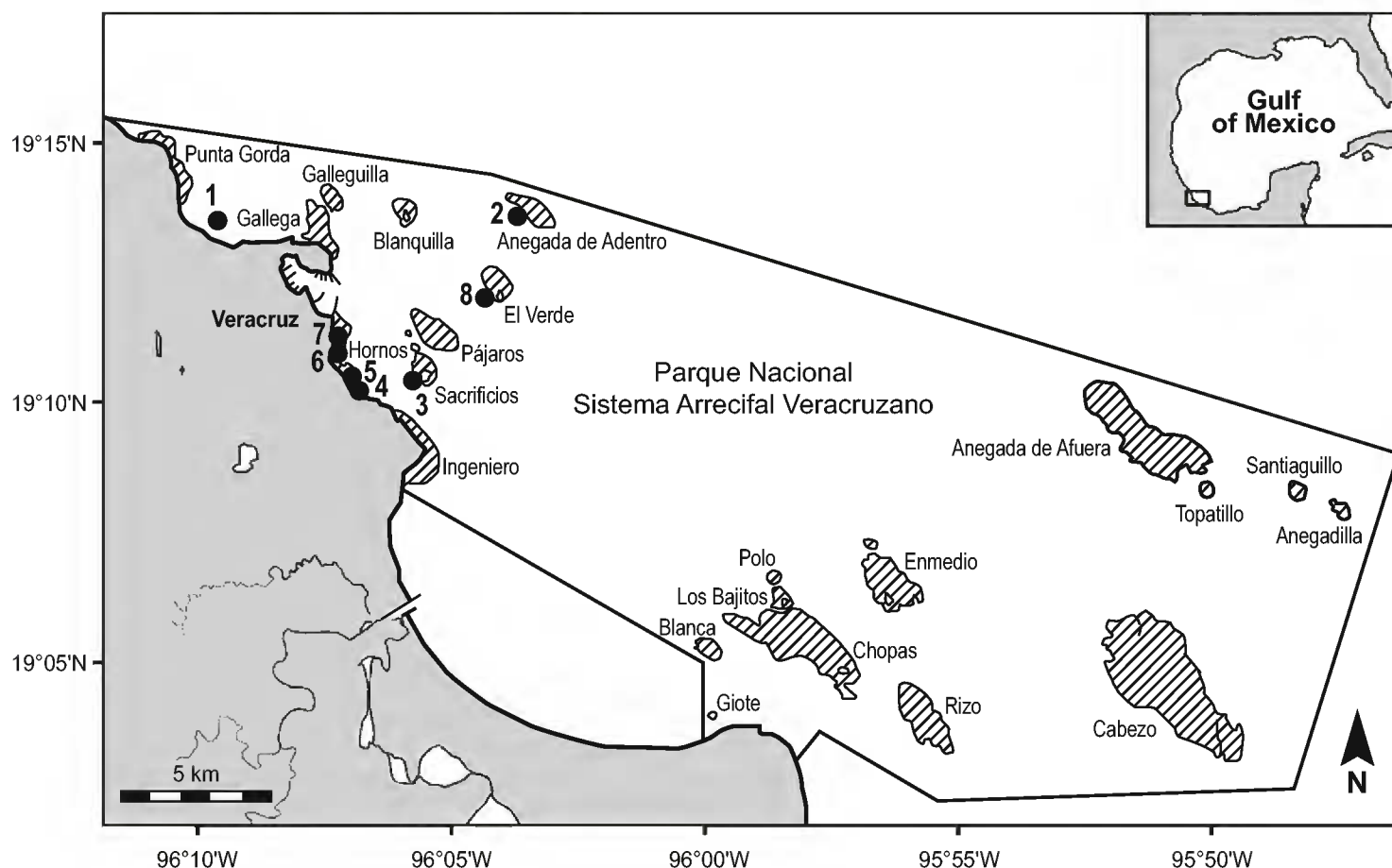


Fig. 1. Sampling sites in the National Park Sistema Arrecifal Veracruzano. Filled circles indicate locations where planktonic dinoflagellates were sampled. Hatched areas are coral reefs.

Table 1. Sampling sites (stations) in the National Park Sistema Arrecifal Veracruzano, Veracruz, Gulf of Mexico, May 2005 - March 2008.

Station	Location	Geographic coordinates
1	Playa Norte - Planta de residuos	19°13'06.0" N, 96°09'34.5" W
2	Arrecife Anegada de Adentro	19°13'41.1" N, 96°03'44.4" W
3	Arrecife Isla de Sacrificios	19°10'32.7" N, 96°05'40.9" W
4	Hotel "Lois"	19°10'27.1" N, 96°06'51.3" W
5	Asta Bandera	19°10'37.4" N, 96°07'10.9" W
6	Hotel "Villa del Mar"	19°11'04.6" N, 96°07'20.6" W
7	Acuario - Escuela Náutica	19°11'15.2" N, 96°07'19.4" W
8	Isla Verde	19°12'12.2" N, 96°04'00.1" W

TS100 and an Olympus CKX41 inverted microscope for a Sedgwick-Rafter 1-ml chamber and an Olympus BX51 compound microscope for water mounts. The cells were photographed mainly with an Olympus C7070 digital camera. Line drawings were made from digital images.

About 90 publications, abstracts and theses on the phytoplankton and dinoflagellates of the Gulf of Mexico were examined, with special emphasis on the state of Veracruz. Extensive old and new literature containing illustrations were analyzed and cited. The works where the species are illustrated are marked with asterisks: an asterisk (*) indicates line drawings, two asterisks (**) indicate light micrographs, and three asterisks (***) indicate scanning electron micrographs. The cited literature is referred to a species in general, not to a given infraspecific taxon. Relative abundance was given according to the following criteria: extremely rare – found in <1% of the analyzed samples only occasionally (less than 25 cells were found in total), rare – encountered in 1 to 10% of the samples as rare cells, common – seen in 11 to 50% of the samples (normally as dozens of cells in a Sedgwick-Rafter chamber), and very common – found in >50% of the samples (dozens or hundreds of cells per chamber).

The abbreviations for cell measurements are as follows: L – total length measured from the furthest part of the hypotheca including the antapical horns; Wb – cell body

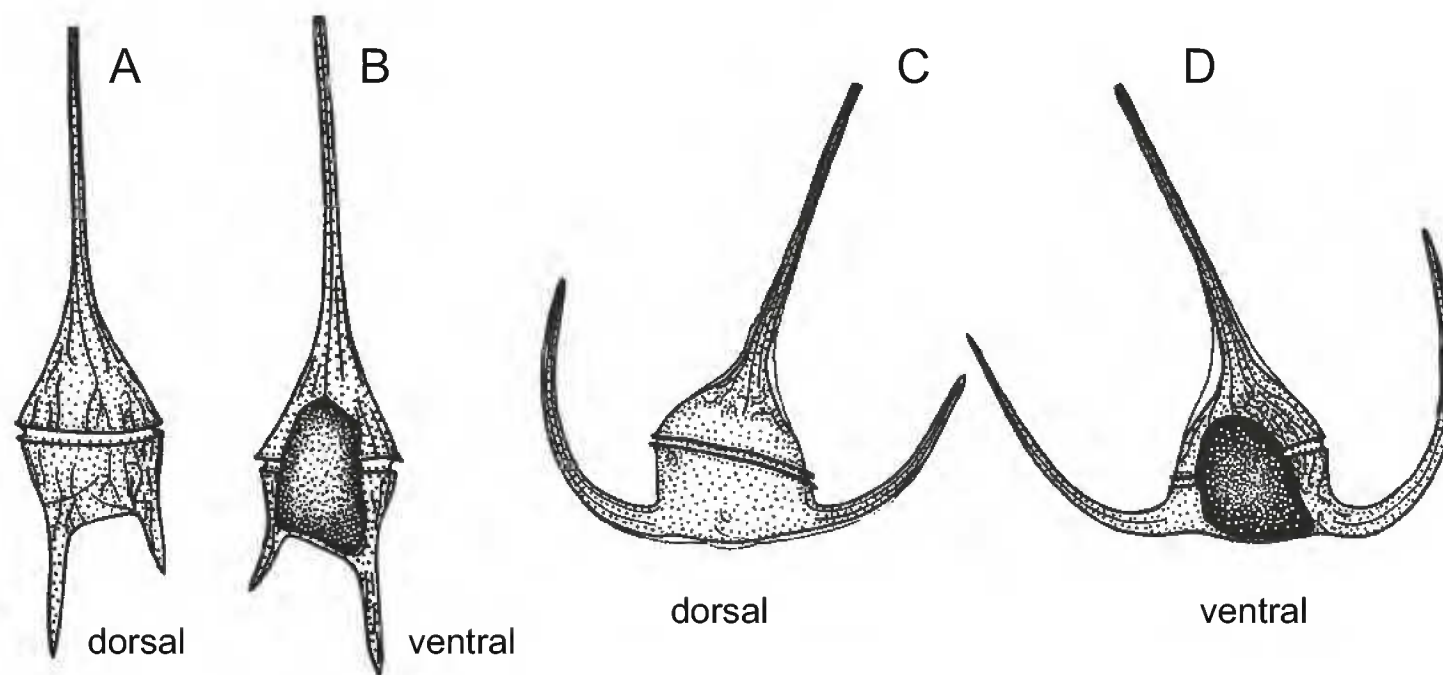


Fig. 2. Line drawings of two morphological cell types in the genus *Ceratium* in dorsal and ventral views: A and B – subgenera *Amphiceratium* and *Ceratium*, C and D – subgenus *Tripoceratium*; the apical horn and the anterior part of the cell are situated above in each drawing (after Wiktor & Okolodkov, 1995).

width measured in ventral or dorsal view just in front of or behind the cingulum, not considering the precingular or postcingular membranes (the only measured width in the species with straight or slightly curved antapical horns directed backward; always measured using the 40x objective to avoid a large error); Wt – total width, considering the distance between external sides of the antapical horns directed laterally, forward or laterally-forward. Cells were measured in dorsal (DV) or ventral view (VV); to facilitate identification, drawings of two morphological cell types in both views are given in Fig. 2. Recently divided cells with undeveloped horns (Pl. 8, Fig. 1-8), teratologic forms (Pl. 7, Fig. 2) and microgametes (Pl. 7, Fig. 3) were avoided during measurements.

RESULTS

Key for identification of species of the genus *Ceratium*

- 1a Cells with 1 or 2 antapical horns directed posteriorly (subgenera *Amphiceratium* and *Ceratium*) 2
- 1b Cells with 2 antapical horns directed anteriorly (subgenus *Tripoceratium*) 10

- 2a Cells long or very long, spindle-shaped or needle-shaped, cell body not differentiated or weakly differentiated from the apical horn, with 1 very long antapical horn, another one may be absent or strongly reduced (subgenus *Amphiceratium*) ...
..... 3
- 2b Cells rather short or sometimes very long, cell body well differentiated from the apical horn (with some exceptions), with 2 well developed antapical horns (subgenus *Ceratium*) 9

- 3a Cells with epitheca and hypotheca equal or subequal in length 4
- 3b Cells with hypotheca much longer (about 1.5-2.0 times) than epitheca
..... (1) *C. extensum*

- 4a Cells generally less than 500 μm long, with slightly curved horns 5
- 4b Cells longer than 500 μm , with notably curved left antapical horn 7

- 5a Cell body occupies about one-third of the total length, constricted in the proximal part of the epitheca (2) *C. geniculatum*

- 5b Cell body occupies less than a quarter of the total length, without a constriction in the epitheca 6
- 6a Cell body strongly inflated, subovoid (3) *C. bigelowii*
 6b Cell body slightly inflated, fusiform (4) *C. fusus*
- 7a Cell body more or less clearly differentiated from the apical horn
 (5) *C. inflatum*
 7b Cell body not differentiated or weakly differentiated from the apical horn 8
- 8a Hypotheca about one-half of the epitheca in length (6) *C. belone*
 8b Hypotheca and epitheca equal or subequal in length (7) *C. longirostrum*
- 9a Cell body about twice as wide as long, with the apical horn emerging eccentrically (8) *C. candelabrum*
 9b Cell body slightly longer than wide or as long as wide, with the apical horn emerging centrally 10
- 10a Cell body poorly differentiated from the apical horn (9) *C. furca*
 10b Cell body well differentiated from the apical horn 11
- 11a Cell body as long as wide, almost regularly pentagonal, >50 µm wide
 (10) *C. pentagonum*
 11b Cell body slightly longer than wide, <50 µm wide 12
- 12a Cells with slightly convex sides, >30 µm wide, with very short antapical horns and poorly distinguished cingulum (11) *C. teres*
 12b Cells with straight sides, <26 µm wide, with relatively longer antapical horns and well distinguished cingulum (12) *C. kofoidii*
- 13a Cell body covered with coarse reticulations or ridges (13) *C. hexacanthum*
 13b Cells not covered with coarse reticulations or ridges 14
- 14a Right antapical horn about 3 to 4 times longer than left one (14) *C. dens*
 14b Antapical horns more or less equal in length 15
- 15a Antapical horns terminated with finger-shaped appendages (15) *C. ranipes*

15b Antapical horns without finger-shaped appendages	16
16a Cell body subquadrangular or subpentagonal	17
16b Cell body subtriangular	18
17a Cell body subquadrangular, with “shoulders” at its proximal margin, making the apical horn well separated	(16) <i>C. limulus</i>
17b Cell body subpentagonal, with a twisted right antapical horn, abruptly curved in the middle at an angle of 90°	(17) <i>C. gibberum</i> var. <i>dispar</i>
18a Theca strongly sculptured, posterior membrane and membranes on the horns well developed	(18) <i>C. vultur</i>
18b Theca weakly or moderately sculptured, posterior membrane and membranes on the horns usually poorly developed	19
19a Hypotheca strongly or slightly rounded at the posterior end, leading directly into antapical horns, lacking a notch between the bases of the horns	20
19b Hypotheca usually flat or slightly convex at the posterior end, with 1 or 2 antapical horns behind the furthest point of the cell body, frequently with a notch between the horns and between one horn and the cell body	28
20a Cell body width >55 µm	21
20b Cell body width <55 µm	24
21a Cell body almost triangular, with nearly flat sides of the epitheca, antapical horns are developed as well as the apical one	(19) <i>C. lunula</i>
21b Cell body subtriangular, with markedly convex sides of the epitheca, antapical horns are less developed than the apical one	22
22a Right antapical horn twisted in a dorso-ventral plane, apical horn is directed anteriorly at its base and then bends to the right	(20) <i>C. contortum</i>
22b Right antapical horn not twisted in a dorso-ventral plane, apical horn straight or nearly straight although inclined to the right	(21) <i>C. karstenii</i>
23a Cell body with a posterior margin very oblique in relation to the cingulum	(22) <i>C. euarquatum</i>

- 23b Cell body with a posterior margin slightly oblique, almost parallel in relation to the cingulum 24
- 24a Cell body width >60 μm , with almost flat posterior margin (23) *C. tripos*
 24b Cell body width <60 μm , with markedly convex posterior margin 25
- 25a Cells <100 μm wide, right antapical horn is positioned very close to the cell body, antapical horns are very short (24) *C. azoricum*
 25b Cells >100 μm wide, antapical horns are long and positioned far from the cell body at equal distance 26
- 26a Right antapical horn forms a semi-circle with its distal part directed to the left ..
 (25) *C. arietinum* var. *gracilentum*
 26b Both antapical horns are directed anteriorly or anteriorly-laterally 27
- 27a Apical horn is positioned centrally (26) *C. symmetricum*
 27b Apical horn emerges from the left side of the cell body (27) *C. declinatum*
- 28a Cells >800 μm wide (28) *C. carriense*
 28b Cells <600 μm wide 29
- 29a Bases of the antapical horns are directed posteriorly, forming a deep notch between them..... (29) *C. macroceros* var. *gallicum*
 29b Bases of the antapical horns are directed laterally-posteriorly, forming a shallow notch between them 30
- 30a Cell length and width are normally <250 μm (30) *C. horridum*
 30b Cell length and width are normally >300 μm 31
- 31a Cell body robust, subtriangular, posterior membrane well developed, a notch between the antapical horns is notable only near the right horn
 (31) *C. massiliense* var. *armatum*
 31b Cell body delicate, subtrapezoidal, posterior membrane poorly developed, a notch between the antapical horns is symmetrical in relation to them 32
- 32a Cells >50 μm long (32) *C. contrarium*
 32b Cells <50 μm long (33) *C. trichoceros*

TAXONOMIC DESCRIPTIONS

Subgenus *Amphiceratium* Vanhöffen

1. ***Ceratium extensum* (Gourret) Cleve, 1900** (Pl. 1, Fig. 1 and 2; Pl. 10, Fig. 1)

Bas.: *Ceratium fusus* var. *extensum* Gourret, 1883: 52, pl. 4, fig. 56.

Syn.: *Ceratium biceps* Claparède et Lachmann, 1859: 400, pl. 19, fig. 8.

Cells spindle-shaped, long. Epitheca tapers into a long apical horn and hypotheca tapers into a long left antapical horn. Left antapical horn markedly (about 1.5 times or more) longer than apical one, both straight or nearly straight. A reduced right antapical horn may be present. Widest point adjacent to the cingulum. L 815-1720 μm ($1253.1 \pm 215.3 \mu\text{m}$), Wb 25-35 μm ($29.2 \pm 2.7 \mu\text{m}$); n=21.

Affinities: *C. fusus*, *C. inflatum*, *C. longirostrum*.

Records in the State of Veracruz: Figueroa-Torres, 1990* **; Suchil-Vilchis, 1990; Zamudio-Reséndiz, 1998. Rare to common in NPSAV (Feb., March, May, July, Aug., Nov., Dec.).

References: Jörgensen, 1911*: 28, fig. 50a; 1920*: 43, fig. 31; Lebour, 1925*: 146, fig. 463; Steemann Nielsen, 1934*: 14, fig. 24; Schiller, 1937*: 380, fig. 419a, b; Rampi, 1939*: 304, fig. 11; Graham & Bronnikovsky, 1944*: 24, fig. 11BB-DD; Kiselev, 1950*: 244, fig. 412; Silva, 1956*: 56, pl. 7, fig. 8 (f. *strictum*); Kato, 1957*: 14, pl. 4, fig. 10a-c; López, 1966*: fig. 12; Subrahmanyam, 1968*: 32, fig. 56, 57; Wood, 1968*: 28, fig. 54; Steidinger & Williams, 1970**: 45, pl. 7, fig. 19; Hassan & Saifullah, 1974*: 85, fig. 10; Taylor, 1976*: 64, pl. 13, fig. 127, 128 (as *C. biceps* Claparède et Lachmann, 1859); Pesantes-Santana, 1978*: 10, pl. 6, fig. 9; Tester & Steidinger, 1979**: 28, pl. 10, fig. 61; Dowidar, 1983*: 12, pl. 2, fig. 5; Balech, 1988*: 133, pl. 55, fig. 1, 2; Konovalova et al., 1989*: 132, fig. 49(3); Licea et al., 1995*: 35, pl. 18, fig. 4; Konovalova, 1998*: 140, fig. 29(4).

2. ***Ceratium geniculatum* (Lemmermann) Cleve, 1901** (Pl. 1, Fig. 3; Pl. 10, Fig. 2)

Bas.: *Ceratium fusus* var. *geniculatum* Lemmermann, 1899: 349, pl. 1, fig. 17.

Cells spindle-shaped, relatively long. The cell body is long, clearly constricted in the middle. Epitheca is inflated, in its distal part suddenly drawn into an apical horn and hypotheca tapers into a long left antapical horn, slightly curved. Apical horn positioned closer to the left side of the cell, notably deflected to the left at its

base. A reduced right antapical horn is present. Widest point adjacent to the cingulum and also in front of the constriction in the middle of the cell body. L 310 μm , Wb 30 μm ; n=1.

A new record for the State of Veracruz. Extremely rare in NPSAV (the only specimen observed was collected on 25 December 2005 relatively far from the shore at st. 2).

References: Karsten, 1907*: pl. 50, fig. 3a, b; Jørgensen, 1911*: 24, fig. 42, 43; 1920*: 34, fig. 24; Böhm, 1931b*: 43, fig. 37c, d; Steemann Nielsen, 1934*: 13, fig. 17; Schiller, 1937*: 375, fig. 414a; Graham & Bronikovsky, 1944*: 22, fig. 11J; Wood, 1954*: 279, fig. 197; 1968*: 30, fig. 60; Sournia, 1968*: 407, fig. 30, 31; Subrahmanyan, 1968*: 28, fig. 43-45; Konovalova, 1998*: 137, fig. 28(9).

3. *Ceratium bigelowii* Kof., 1907 (Pl. 1, Fig. 4 and 5; Pl. 10, Fig. 3)

Cells spindle-shaped, long. Cell body is well distinguished, inflated, suboval. Epitheca tapers into a long apical horn and hypotheca tapers into a long left antapical horn. Apical and left antapical horns equal or subequal in length; apical horn slightly curved and the left antapical horn notably continuously curved. A reduced right antapical horn may be present. Widest point adjacent to the cingulum. L 375 μm , Wb 30 μm ; n=1.

Affinities: *C. fusus*. Unlike in *C. fusus*, in *C. bigelowii* the cell is markedly inflated in the middle, and therefore the cell body is well separated from the horns.

A new record for the State of Veracruz. Extremely rare in NPSAV (the only specimen observed was collected on 1 March 2008 relatively far from the shore: 10°02'43.1" N, 95°49'25.4" W).

References: Kofoid, 1907a*: 170, pl. 3, fig. 22; Jørgensen, 1911*: 25, fig. 44; Böhm, 1931b*: 43, fig. 37b; Steemann Nielsen, 1934*: 13, fig. 18; Schiller, 1937*: 376, fig. 414b; Graham & Bronikovsky, 1944*: 22, fig. 11I, K-M; Wood, 1963*: 39, fig. 143; Subrahmanyan, 1968*: 28, fig. 46, 47; Steidinger & Williams, 1970**: 44, pl. 4, fig. 11; Konovalova, 1998*: 141, fig. 29(3).

4. *Ceratium fusus* (Ehrenb.) Dujard., 1841 (Pl. 1, Fig. 6 and 7; Pl. 10, Fig. 4)

Bas.: *Peridinium fusus* Ehrenb., 1834: 271, 1835.

Syn: *C. seta* (Ehrenb.) Kofoid, 1908: 387.

Cells spindle-shaped, long. Epitheca tapers continuously into a long apical horn and hypotheca tapers into a long left antapical horn. Apical and left antapical

horns equal or subequal in length and slightly curved. A reduced right antapical horn may be present. Widest point adjacent to the cingulum. L 243-580 μm ($422.4 \pm 80.9 \mu\text{m}$), Wb 15-25 μm ($20.4 \pm 4.0 \mu\text{m}$); n=22.

Affinities: *C. extensum*, *C. inflatum*, *C. longirostrum*, *C. bigelowii*. I preferred not to distinguish the two forms of *C. fusus* given in Steidinger et al. (2009) for the Gulf of Mexico.

Records in the State of Veracruz: Ochoa-Figueroa, 1978; Avendaño-Sánchez & Sotomayor-Navarro, 1982; Echeverría-Valencia, 1983; Figueroa-Torres, 1990* **; Suchil-Vilchis, 1990*; Zamudio-Resendiz, 1998; Aquino-Cruz, 2002* **; Legaría-Moreno, 2003; Estradas-Romero, 2004. Very common in NPSAV throughout the year.

References: Ostenfeld, 1903*: 587, fig. 145, 146; Paulsen, 1908*: 90, fig. 123; Jörgensen, 1911*: 29, fig. 51-53; 1920*: 41, fig. 30; Lebour, 1925*: 146, pl. 31, fig. 1; Wailes, 1928*: 5, pl. 1, fig. 5, 6, pl. 12, fig. 21, 22 (a teratologic form); Böhm, 1931b*: 14, fig. 10c-f; Steemann Nielsen, 1934*: 14, fig. 25, 26; Schiller, 1937*: 378, fig. 418a, b; Rampi, 1939*: 303, fig. 12, 13; Graham & Bronikovsky, 1944*: 25, fig. 11EE, 13A-D; Kiselev, 1950*: 245, fig. 419; Wood, 1954*: 282, fig. 202; 1968*: 29, fig. 58; Kato, 1957*: 13, pl. 3, fig. 5a-c, 6a, b (*C. fusus* and *C. fusus* var. *seta*); Curl, 1959*: 306, fig. 116; Margalef, 1961a*: 81, fig. 26e-g; López, 1966*: fig. 11; Sournia, 1968*: 408, 32, 33, 34(?) (three varieties are illustrated); Subrahmanyam, 1968*: 31, fig. 55, pl. 1, fig. 3-6; Steidinger & Williams, 1970**: 45, pl. 8, fig. 21a, b; Drebes, 1974**: 145, fig. 128a; Hassan & Saifullah, 1974*: 85, fig. 9 (*C. fusus* var. *seta*); Taylor, 1976*: 66, pl. 13, fig. 129, 130, 136, 137; Pesantes-Santana, 1978*: 12, pl. 6, fig. 3-7; Trégouboff, 1978*: 115, pl. 25, fig. 13A-D; Tester & Steidinger, 1979**: 28, pl. 11, fig. 63; Burns & Mitchell, 1980***: 150, fig. 3; Dodge, 1982*: 231, fig. 29C; Dowidar, 1983*: 11, pl. 1, fig. 8; Balech, 1988*: 132, pl. 54, fig. 5, 6, 8; Konovalova et al., 1989* **: 132, fig. 49(5-7), pl. 15, fig. 7 (three varieties are illustrated); Delgado & Fortuño, 1991***: 6, pl. 8, fig. c, d; Licea et al., 1995**: 37, pl. 3, fig. 2; 2004**: fig. 3, 12 (var. *fusus* and var. *seta*); Wiktor & Okolodkov, 1995*: 36, fig. 10a-c; Steidinger & Tangen, 1997*: 472, pl. 25; Konovalova, 1998* ***: fig. 29(5, 6, 15), pl. 13, fig. 9 (three varieties are illustrated); Bérard-Therriault et al., 1999**: 164, pl. 83a; Avancini et al., 2006* **: 289, fig. A-D (var. *seta*); Hoppenrath et al., 2009**: 173, fig. 70b, c; Yongshui, 2009**: pl. 2, fig. 8.

5. *Ceratium inflatum* (Kof.) Jörg., 1920 (Pl. 1, Fig. 8; Pl. 10, Fig. 5)

Bas.: *Ceratium pennatum* f. *inflatum* Kofoid, 1907 (Bull. Mus. Comp. Zool. Harv. Coll. 50, 6): 172, pl. 2, fig. 13.

Cells spindle-shaped, long. Epitheca tapers into a long apical horn and hypotheca tapers into a long left antapical horn; however, the cell body is distinguished, inflated. Apical and left antapical horns equal or subequal in length; apical horn straight or slightly curved and the left antapical horn more curved continuously or rather abruptly at its distal third. A reduced right antapical horn may be present. Widest point adjacent to the cingulum. L 595-690 μm ($634\pm 39.3 \mu\text{m}$), Wb 22.5-32.5 μm ($27.4\pm 3.3 \mu\text{m}$); n=8. Rare in NPSAV (March, Oct.).

Affinities: *C. fusus*, *C. longirostrum*, *C. extensum*, *C. bigelowii*. The species is distinguished from the former three species by its more inflated cell body.

References: Jørgensen, 1911*: 25, fig. 45, 46, 48a; 1920*: 35, fig. 25; Böhm, 1931a*: 353, fig. 3, 4; 1931b*: 14, fig. 10a, b; Schiller, 1937*: 376, fig. 415a, b; Graham & Bronikovsky, 1944*: 23, fig. 11O-S; Kiselev, 1950*: 245, fig. 462; Wood, 1954*: 281, fig. 198; Silva, 1956*: 56, pl. 7, fig. 9; Kato, 1957*: 14, pl. 3, fig. 7; López, 1966*: fig. 10; Sournia, 1968*: 412, fig. 36; Subrahmanyam, 1968*: 29, fig. 48, 49; Steidinger & Williams, 1970**: 46, pl. 10, fig. 25; Trégouboff, 1978*: 115, pl. 25, fig. 10; Dodge, 1982*: 231, fig. 29B; Steidinger & Tangen, 1997*: 474, pl. 25; Konovalova, 1998*: 140, fig. 29(2); Yongshui, 2009**: pl. 2, fig. 9.

6. *Ceratium belone* Cleve, 1900 (Pl. 2, Fig. 1 and 2; Pl. 10, Fig. 6)

Cells spindle-shaped, long. Epitheca continuously tapers into a long apical horn. Hypotheca with two well developed antapical horns, parallel to each other. Left antapical horn about twice as long as right one. Widest region adjacent to the cingulum and occupies nearly all the proximal part of hypotheca. L 680-880 μm ($729.5\pm 100.7 \mu\text{m}$), Wb 27.5-31 μm ($29.6\pm 1.5 \mu\text{m}$); n=4.

Records in the State of Veracruz: Zamudio-Resendiz, 1998. Extremely rare in NPSAV; four specimens were found on 11 December 2007 at st. 2 and on 1 March 2008 at st. 4.

References: Jørgensen, 1911*: 19, fig. 28a, b; 1920*: 22, fig. 14; Steemann Nielsen, 1934*: 10, fig. 10; Schiller, 1937*: 369, fig. 407a; Rampi, 1942*: 222, fig. 2; Graham & Bronikovsky, 1944*: 19, fig. 8; Sournia, 1968*: 399, fig. 22; Subrahmanyam, 1968*: 20, fig. 30; Wood, 1968*: 24, fig. 40; Steidinger & Williams, 1970**: 44, pl. 4, fig. 10; Taylor, 1976*: 58, pl. 12, fig. 119; Trégouboff, 1978*: 114, pl. 25, fig. 6; Tester & Steidinger, 1979**: 27, pl. 10, fig. 57; Dowidar, 1983*: 10, pl. 2, fig. 4; Balch, 1988*: 132, pl. 56, fig. 1; Delgado & Fortuño, 1991*: fig. 6B; Licea et al., 1995: 30, pl. 17, fig. 6 (also, referred by mistake to pl. 1, fig. 5, in which *C. candelabrum* is given); Yongshui, 2009* **: 8, fig. 8, pl. 1, fig. 5.

7. *Ceratium longirostrum* Gourret, 1883 (Pl. 2, Fig. 3 and 4; Pl. 10, Fig. 7)

Cells needle-shaped, very long. Epitheca tapers into a long apical horn and hypotheca tapers into a long left antapical horn. Apical and left antapical horn equal or subequal in length, apical horn being slightly curved and left antapical horn notably curved. A reduced right antapical horn may be present. Widest point adjacent to the cingulum. L 268-690 μm ($621.8 \pm 78.6 \mu\text{m}$), Wb 17.5-32.5 μm ($27.9 \pm 3.9 \mu\text{m}$); n=29.

Affinities: *C. fusus*, *C. extensum*, *C. inflatum*.

Records in the State of Veracruz: Figueroa-Torres, 1990* **. Rare in NPSAV (Jan. to March, May, Aug. to Dec.).

References: Jørgensen, 1920*: 37, fig. 26, 27; Böhm, 1931a*: 354, fig. 5; Steemann Nielsen, 1934*: 13, fig. 21; Schiller, 1937*: 376, fig. 416a, b; Rampi, 1939*: 303, fig. 9; Graham & Bronikovsky, 1944*: 24, fig. 11T-V; Wood, 1954*: 281, fig. 199; 1968*: 35, fig. 75; Silva, 1956*: 57, pl. 7, fig. 10; López, 1966*: fig. 15; Sournia, 1968*: 413, fig. 37; Subrahmanyam, 1968*: 30, fig. 50-52; Steidinger & Williams, 1970**: 46, pl. 10, fig. 27; Hassan & Saifullah, 1974*: 85, fig. 8; Taylor, 1976*: 67, pl. 13, fig. 131a, b; Pesantes-Santana, 1978*: 14, pl. 7, fig. 4; Trégouboff, 1978*: 115, pl. 25, fig. 11; Dowidar, 1983*: 12, pl. 2, fig. 8; Balech, 1988*: 134, pl. 55, fig. 10, 11; Delgado & Fortuño, 1991*: fig. 6C; Licea et al., 1995**: 41, pl. 3, fig. 9.

Subgenus *Ceratium* (= *Biceratium* (Vanhöffen) Ostenf.)

8. *Ceratium candelabrum* (Enrenb.) Stein, 1883 (Pl. 2, Fig. 5; Pl. 9, Fig. 1; Pl. 10, Fig. 8)

Bas.: *Peridinium candelabrum* Ehrenb., 1860: 792, pl. 1, fig. 2, 3.

Cells with two robust or stout antapical horns, slightly divergent, left one slightly longer and sometimes thicker. Cell body is about twice as broad as it is high. Epitheca in the form of low cone, with well separated apical horn inserted eccentrically. Hypotheca between the antapical horns markedly inclined towards the cingulum. Widest point adjacent to the cingulum. L 145-345 μm ($243.0 \pm 52.2 \mu\text{m}$), Wb 68-94 μm ($78.0 \pm 7.0 \mu\text{m}$); n=20. Chains of 2 cells were observed.

Note: Steidinger et al. (2009) reported two forms of this species for the Gulf of Mexico. The name of *Ceratium depressum* ascribed to Gourret (the only author, whose name appears in parentheses) given by Suchil-Vilchis (1990) for Veracruz should be considered a nomen nudum.

Records in the State of Veracruz: Avendaño-Sánchez & Sotomayor-Navarro, 1982; Figueroa-Torres, 1990*; Zamudio-Resendiz, 1998. Rare to common in NPS-AV (Jan. to March, May, July, Aug., Nov., Dec.).

References: Paulsen, 1908*: 88, fig. 120; Jörgensen, 1920*: 11, fig. 5, 6; Lebour, 1925*: 143, fig. 45b, c, pl. 30, fig. 2; Böhm, 1931a*: 351, fig. 1, 2 (*C. candelabrum* f. *eucandelabrum* n. f. and f. *hiemale* n. f.), 24 (a teratologic form); 1931b*: 8, fig. 3a-d; Steemann Nielsen, 1934*: 8, fig. 6, 7; Schiller, 1937*: 364, fig. 401; Rampi, 1939*: 302, fig. 4, 5, 7 (three infraspecific taxa are illustrated); 1951*: 6, fig. 7 (a teratologic specimen); Graham & Bronikovsky, 1944*: 17, fig. 6; Kiselev, 1950*: 242, fig. 408; Kato, 1957*: 12, pl. 3, fig. 2 (*C. candelabrum* and *C. candelabrum* var. *depressum*); López, 1966* **: 362, fig. 3, 4, 52, 56-58, 88, 89, photo 1(1, 2) (three infraspecific taxa are illustrated); Sournia, 1968*: 390, fig. 14-17 (two varieties are illustrated; a new combination *C. candelabrum* f. *subrotundum* (Ostenf.) Sournia is proposed); Subrahmanyam, 1968*: 17, fig. 16-20; Wood, 1968*: 25, fig. 44; Hassan & Saifullah, 1974*: 84, fig. 1; Taylor, 1976*: 59, pl. 12, fig. 124-126; Pesantes-Santana, 1978*: 7, pl. 2, fig. 1-3; Trégouboff, 1978*: 114, pl. 25, fig. 4A, B; Burns & Mitchell, 1980***: 149, fig. 1, 2; Dodge, 1982*: 227, fig. 28A, pl. 7, fig. d; 1985***: 94; Dowidar, 1983*: 9, pl. 2, fig. 2; Balech, 1988*: 128, pl. 56, fig. 17, 18, pl. 57, fig. 4, 5; Delgado & Fortuño, 1991* ***: fig. 6I; 5, pl. 5, fig. b; Licea et al., 1995* ***: 31, pl. 1, fig. 5, pl. 17, fig. 8 (also, referred by mistake to pl. 17, fig. 9, in which *C. pentagonum* is given); Steidinger & Tangen, 1997*: 471, pl. 27; Konovalova, 1998*: 133, fig. 28(14); Avancini et al., 2006* **: 281, fig. A-H; Yongshui, 2009* ** ***: 9, fig. 10, 11, pl. 1, fig. 7, 8, pl. 9, fig. 1A, B (var. *candelabrum* and var. *depressum*).

9a. *Ceratium furca* (Ehrenb.) Clap. et J. Lachm., 1859 var. *furca* (Pl. 2, Fig. 6; Pl. 9, Fig. 2; Pl. 10, Fig. 9)

Bas.: *Peridinium furca* Ehrenb., 1835: 574, pl. 2(2).

Syn.: *Ceratium furca* var. *berghii* Lemmermann, 1899: 366; *C. furca* var. *eugrammum* (Ehrenb.) J. Schill., 1937: 368, fig. 405a, b.

Cells with two robust antapical horns, parallel to each other or slightly divergent, parallel or slightly convergent, left one being about twice as long. Epitheca tapers into a rather long apical horn. Hypotheca between the antapical horns markedly inclined towards the cingulum. Widest point adjacent to the cingulum. L 155-260 μm ($214.0 \pm 28.6 \mu\text{m}$), Wb 30-42.5 μm ($35.9 \pm 4.3 \mu\text{m}$); n=20. Chains of 2 cells were observed.

Records in the State of Veracruz: Avendaño-Sánchez & Sotomayor-Navarro, 1982; Echeverría-Valencia, 1983*; Hernández-Mendiola, 1988; Figueroa-Torres, 1990* **; Suchil-Vilchis, 1990; Zamudio-Resendiz, 1998; Aquino-Cruz, 2002* **; García-Reséndiz, 2003; Legaría-Moreno, 2003; Estradas-Romero, 2004; Tejeda-Hernández, 2005**. Very common in NPSAV throughout the year.

References: Paulsen, 1908*: 90, fig. 122; 1931*: 76, fig. 46; Jörgensen, 1920*: 17, fig. 7-12; Lebour, 1925*: 145, pl. 30, fig. 3; Wailes, 1928*: 5, pl. 1, fig. 8, pl. 2, fig. 10; Böhm, 1931b*: 8, fig. 4-8; Steemann Nielsen, 1934* **: 9, fig. 8, 9, photo 1(5, 6); Schiller, 1937*: 367, fig. 404-405; Rampi, 1939*: 302, fig. 8; Graham & Bronikovsky, 1944*: 18, fig. 7; Kiselev, 1950*: 243, fig. 415, 416, 427; Wood, 1954*: 274, fig. 189a-c; 1968*: 29, fig. 57; Kato, 1957*: 12, pl. 3, fig. 4a, b; Curl, 1959*: 305, fig. 115; López, 1966* **: 371, fig. 6, 7, 68, 72, 92, 93 (*C. furca eugrammum* and *C. furca Berghii*), photo 1(5, 6); Sournia, 1968*: 395, fig. 18-20 (var. *furca* and var. *eugrammum*); Steidinger et al., 1967**: pl. 5, fig. e; Subrahmanyam, 1968*: 20, fig. 21-29, pl. 2, fig. 7-12; Steidinger & Williams, 1970**: 45, pl. 7, fig. 20a, b; Hermosilla, 1973*: 62, pl. 33, fig. 1, 2, 7, 8; Drebes, 1974**: 145, fig. 128b; Hassan & Saifullah, 1974*: 84, fig. 2, 3 (var. *furca* and var. *eugrammum*); Taylor, 1976*: 60, pl. 12, fig. 109; Trégouboff, 1978*: 114, pl. 25, fig. 5A, B; Burns & Mitchell, 1980***: 150, fig. 4-10; Dodge, 1982*: 228, fig. 28C, pl. 8, fig. e; 1985***: 96, right fig.; Pesantes-Santana, 1978* (other varieties than var. *furca*): 11, pl. 8, fig. 1-3 (*Ceratium furca* var. *berghii* f. *bergii* López, 1966; with an orthographic error in the name of the form), pl. 4, 5 (*C. furca* var. *eugrammun* (Ehrenb.) J. Schill., 1937; with an orthographic error in the name of the variety); Dowidar, 1983*: 9, pl. 2, fig. 3; Balech, 1988*: 131, pl. 56, fig. 4-6; Konovalova et al., 1989*: 132, fig. 49(4); Delgado & Fortuño, 1991* **: fig. 6D, E; 5, pl. 3, fig. a, b; Licea et al., 1995***: 36, pl. 2, fig. 7; 2004**: fig. 2, 8 (also as *C. furca* var. *eugrammun*); Wiktor & Okolodkov, 1995*: 34, fig. 9a, b; Steidinger & Tangen, 1997*: 472, pl. 25; Konovalova, 1998*: 136, fig. 28(7); Avancini et al., 2006* **: 286, fig. A, B; Alonso-Rodríguez et al., 2008**: 127; Hoppenrath et al., 2009**: 173, fig. 70d-g; Yongshui, 2009* ** ***: 12, fig. 13, 14, pl. 1, fig. 9, 10, pl. 9, fig. 2A, B (var. *furca* and var. *eugrammum*).

9b. *Ceratium furca* var. *hircus* (Schröd.) Margalef, 1961 ex Sournia, 1973 (Pl. 2, Fig. 7; Pl. 3, Fig. 1; Pl. 9, Fig. 3; Pl. 10, Fig. 10)
Bas.: *Ceratium hircus* Schröder, 1909: 213, fig. 2.

Cells with two robust, slightly divergent antapical horns, equal or subequal in length. Epitheca tapers into a rather long apical horn. Hypotheca between the

antapical horns markedly inclined towards the cingulum. Widest point adjacent to the cingulum. L 137-220 μm ($166.7 \pm 11.3 \mu\text{m}$), Wb 31-53 μm ($36.8 \pm 4.3 \mu\text{m}$); n=28. Chains of 2 cells were observed.

Records in the State of Veracruz: Figueroa-Torres, 1990* **; Guerra-Martínez & Lara-Villa, 1996**; Zamudio-Resendiz, 1998; Aquino-Cruz, 2002* **; Legaría-Moreno, 2003; Tejeda-Hernández, 2005**. Common in NPSAV throughout the year.

References: Schiller, 1937*: 369, fig. 406; Margalef, 1961a*: 81, fig. 26c, d; Steidinger & Williams, 1970**: 45, pl. 9, fig. 24a, b; Tester & Steidinger, 1979**: 28, pl. 11, fig. 65; López-Baluja, 1980*: 5, fig. 2; Balech, 1988*: 196, pl. 69, fig. 6; Licea et al., 1995** ***: 37, pl. 2, fig. 9, pl. 3, fig. 1; Yongshui, 2009*: 13, fig. 15, 16 (var. *hircus* and var. *sinicum* Nie).

10. *Ceratium pentagonum* Gourret, 1883 var. *tenerum* Jörg., 1920 (Pl. 3, Fig. 2 and 3; Pl. 8, Fig. 1; Pl. 10, Fig. 11)

Cells pentagonal with two slightly diverging antapical horns. Antapical horns short, left one about 1.5 times longer. Epitheca in the form of low cone, with well separated apical horn inserted centrally. Hypotheca between the antapical horns markedly inclined towards the cingulum. Widest point adjacent to the cingulum. L 120-210 μm ($156.2 \pm 23.4 \mu\text{m}$), Wb 46-55 μm ($51.3 \pm 3.8 \mu\text{m}$); n=21.

Records in the State of Veracruz: Ochoa-Figueroa, 1978; Avendaño-Sánchez & Sotomayor-Navarro, 1982; Echeverría-Valencia, 1983*: pl. 8, fig. 19B(?), non 19A (the cell illustrated in fig. 19A is likely *C. minutum*); Figueroa-Torres, 1990* **; Suchil-Vilchis, 1990; Zamudio-Resendiz, 1998; Aquino-Cruz, 2002* **; Estradas-Romero, 2004; Tejeda-Hernández, 2005**. Very common in NPSAV throughout the year.

References: Jörgensen, 1911*: 20, fig. 31, 32; 1920*: 24, fig. 15-17; Böhm, 1931b*: 12, fig. 9b; Steemann Nielsen, 1934*: 11, fig. 12; Rampi, 1939*: 302, fig. 16, 17, 20 (two forms are illustrated); Graham & Bronikovsky, 1944*: 20, fig. 10C, D, H-N; Kiselev, 1950*: 243, fig. 417, 418; Silva, 1952a*: 39, pl. 3, fig. 15; 1956*: 51, pl. 7, fig. 3, 4 (subsp. *robustum*, subsp. *tenerum* and var. *turgidum*); Gaarder, 1954*: 15, fig. 14 (as *C. pentagonum* f. *tenerum* (Jörgensen)); Kato, 1957*: 13, pl. 4, fig. 9; Curl, 1959*: 306, fig. 120; Margalef, 1961a*: 81, pl. 6; López, 1966* **: 367, fig. 5, 59, 63, 90, photo 1(3, 4); Sournia, 1968*: 400, fig. 23, 24; Subrahmanyam, 1968*: 23, fig. 32, 33; Wood, 1968*: 37, fig. 82, 39; Steidinger & Williams, 1970**: 47, pl. 12, fig. 31; Hermosilla, 1973*: 62, pl. 32, fig. 4-6, 8 (as *C. pentagonum* var. *robustum* (Cleve) Jörg.); Hassan & Saifullah, 1974*: 84, fig. 5 (var. *robustum*); Balech, 1976*: 90, fig. 12 (*C. pentagonum* ssp.

grande Mangin, 1926); 1988*: 128, pl. 56, fig. 14-16, pl. 57, fig. 1-3; Taylor, 1976*: 62, pl. 12, fig. 111-113 (three varieties are illustrated); Trégouboff, 1978*: 114, pl. 25, fig. 7; Tester & Steidinger, 1979**: 29, pl. 11, fig. 70; Dowidar, 1983*: 10, pl. 3, fig. 1; Dodge, 1985***: 96, left fig.; Pesantes-Santana, 1978*: 15, 16, pl. 8, fig. 6, 7; Konovalova et al., 1989*: 136, fig. 50(4); Delgado & Fortuño, 1991* ***: fig. 6N; 6, pl. 9, fig. c; Licea et al., 1995* **: 44, pl. 1, fig. 6, pl. 4, fig. 5, pl. 19, fig. 7-9; 2004*: fig. 6; Steidinger & Tangen, 1997*: 477, pl. 26; Konovalova, 1998* ***: 134, fig. 28(11, 12), pl. 12, fig. 6 (var. *pentagonum* and var. *turgidum* Jörg.); Avancini et al., 2006* **: 293, fig. A-D.

11. *Ceratium teres* Kof., 1907 (Pl. 3, Fig. 4; Pl. 10, Fig. 12)

Cells with a body with straight or slightly convex sides and slender, delicate horns. Epitheca triangular, with well separated apical horn. Antapical horns short, left one about twice as long. Widest point adjacent to the cingulum. Theca not sculptured or only weakly sculptured. L 100-153 μm ($129.7 \pm 15.8 \mu\text{m}$), Wb 35-41 μm ($38.4 \pm 2.4 \mu\text{m}$); n=23.

Affinities: *C. kofoidii*, *C. lineatum*. *C. teres* is distinguished from *C. kofoidii* by its longer cells, usually with slightly convex sides of the cell body and poorly marked cingulum.

Records in the State of Veracruz: Figueroa-Torres, 1990* **: Zamudio-Resendiz, 1998. Very common in NPSAV throughout the year.

References: Kofoid, 1907b*: 308, fig. 34-36; Jörgensen, 1911*: 21, pl. 2, fig. 34, 35; Böhm, 1931b*: 12, fig. 9d; Steemann Nielsen, 1934*: 11, fig. 14; Schiller, 1937*: 372, fig. 409a, b; Rampi, 1939*: 303, fig. 6; Graham & Bronikovsky, 1944*: 21, fig. 11B-D; López, 1966* **: 371, fig. 8, 64, 91, photo 1(7); Sournia, 1968*: 405, fig. 28; Subrahmanyam, 1968*: 24, fig. 34, 35; Wood, 1968*: 40, fig. 90; Steidinger & Williams, 1970**: 47, pl. 13, fig. 35a, b; Taylor, 1976* **: 63, pl. 12, fig. 110, pl. 40, fig. 484; Pesantes-Santana, 1978*: 17, fig. 9; Trégouboff, 1978*: 115, pl. 25, fig. 8; Burns & Mitchell, 1980***: 150, fig. 15; Dowidar, 1983*: 11, pl. 1, fig. 3; Balech, 1988*: 131, pl. 56, fig. 7; Licea et al., 1995**: 47, pl. 5, fig. 3; 2004**: fig. 5; Steidinger & Tangen, 1997*: 478, pl. 26; Konovalova, 1998*: 135, fig. 28(13); Yongshui, 2009* ** ***: 18, fig. 22, pl. 2, fig. 4, pl. 10, fig. 2.

12. *Ceratium kofoidii* Jörg., 1911 (Pl. 3, Fig. 5; Pl. 10, Fig. 13)

Cells with a body with straight sides and slender, delicate horns. Epitheca triangular, with well separated apical horn. Antapical horns short, the left being slightly

longer. Widest point adjacent to the cingulum. Theca not sculptured or only weakly sculptured. L 110-210 μm ($141.6 \pm 26.8 \mu\text{m}$), Wb 20-28 μm ($24.4 \pm 1.6 \mu\text{m}$); n=20.

Affinities: *C. lineatum*, *C. teres*. *C. kofoidii* is distinguished from *C. teres* by its smaller size, straight sides of the cell body and a well marked cingulum.

Records in the State of Veracruz: Suchil-Vilchis, 1990; Zamudio-Resendiz, 1998; Estradas-Romero, 2004. Very common in NPSAV throughout the year.

References: Jørgensen, 1911*: 23, fig. 38, 39; 1920*: 33, fig. 20; Böhm, 1931b*: 12, fig. 9c, e-g; Steemann Nielsen, 1934*: 11, fig. 15; Schiller, 1937*: 373, fig. 412a, b; Rampi, 1942*: 223, fig. 5; Graham & Bronnikovsky, 1944*: 21, fig. 11H; Kiselev, 1950*: 244, fig. 409; Silva, 1956*: 55, pl. 7, fig. 7; Sournia, 1968*: 406, fig. 29; Subrahmanyam, 1968*: 26, fig. 41, 42; Wood, 1968*: 33, fig. 69; Steidinger & Williams, 1970**: 46, pl. 10, fig. 26; Hassan & Saifullah, 1974*: 84, fig. 6; Dowidar, 1983*: 11, pl. 1, fig. 4; Licea et al., 1995*: 41, pl. 19, fig. 2; 2004**: fig. 7; Steidinger & Tangen, 1997*: 475, pl. 25; Konovalova, 1998* ***: 137, fig. 29(8), pl. 13, fig. 5-8; Alonso-Rodríguez et al., 2008**: 128.

Subgenus *Tripoceratium* Kofoid

13. *Ceratium hexacanthum* Gourret, 1883 (Pl. 3, Fig. 6 and 7; Pl. 9, Fig. 4; Pl. 11, Fig. 1)

Syn.: *Ceratium tripos* var. *reticulata* Pouchet, 1883: 423, fig. 3; *C. reticulatum* (Pouchet) Cleve, 1903: 342.

Cell body covered with coarse reticulations in the form of ridges. Epitheca convex, cell body well differentiated from the apical horn. Right antapical horn arises immediately behind the cingulum and bends laterally-anteriorly. Left antapical horn bends around toward the dorsal side of the cell so that its distal part is directed ventrally-right. Widest point adjacent to the antapical horns. L 85-735 μm ($422 \pm 223.1 \mu\text{m}$), Wb 70-87.5 μm ($81.3 \pm 4.7 \mu\text{m}$), Wt 250-440 μm ($333.6 \pm 73.2 \mu\text{m}$); n=7. Chains of 2 cells were observed.

Note: Although Licea et al. (2004) consider this dinoflagellate species one of the 30 most common in the southern Gulf of Mexico, it is extremely rare in Veracruz waters, including NPSAV (March, May, July, Aug., Oct. to Dec.).

Records in the State of Veracruz: Figueroa-Torres, 1990*.

References: Karsten, 1907*: pl. 50, fig. 4, 5 (as *C. tripos reticulatum* Pouchet var. *contorta* Gourret); Pavillard, 1916*: 19, fig. 1; Jørgensen, 1920*: 101, fig. 94;

Böhm, 1931a*: 366, fig. 22 (as *C. hexacanthum* f. *contortum* (Lemmermann), 23; Steemann Nielsen, 1934*: 29, fig. 73; Schiller, 1937*: 421, fig. 462a-c; Rampi, 1939*: 308, fig. 44; 1942*: 227, fig. 710-712 (two forms are illustrated); Graham & Bronikovsky, 1944*: 44, fig. 27F, G; Kiselev, 1950*: 254, fig. 438; Wood, 1954*: 306, fig. 462a, b; 1968*: 31, fig. 63; López, 1966*: fig. 38; Sournia, 1968*: 484, fig. 98 (six infraspecific taxa are proposed, including a new combination *C. hexacanthum* f. *pavillardii* (Rampi) Sournia); Subrahmanyam, 1968*: 72, fig. 140, 141; Steidinger & Williams, 1970**: 45, pl. 9, fig. 23a-c; Hassan, 1976*: 291, fig. 17a, b; Taylor, 1976*: 70, pl. 22, fig. 214, 215, 219; Pesantes-Santana, 1978*: 13, pl. 10, fig. 4, 5; Trégouboff, 1978*: 116, pl. 26, fig. 13, 14A, B; Tester & Steidinger, 1979**: 28, pl. 11, fig. 64; Dodge, 1982*: 236, fig. 30H, pl. 7, fig. e; Dowidar, 1983*: 20, pl. 5, fig. 6; Balech, 1988*: 152, pl. 69, fig. 1, 2; Konovalova et al., 1989*: 134, fig. 49(8); Delgado & Fortuño, 1991***: 6, pl. 7, fig. a-d; Licea et al., 1995*: 39, pl. 18, fig. 10a, b (as *C. hexacanthum* var. *contortum* Lemmermann); Steidinger & Tangen, 1997*: 474, pl. 27; Konovalova, 1998*: 164, fig. 36(1); Yongshui, 2009** ***: pl. 2, fig. 12, 13, pl. 12, fig. 1A-C, 2 (var. *hexacanthum* f. *spirale* and var. *contortum*).

14. ***Ceratium dens* Ostenf. et J. Schmidt, 1901** (Pl. 3, Fig. 8; Pl. 9, Fig. 5 and 6; Pl. 11, Fig. 2)

Cell body almost triangular, with slightly convex sides of the epitheca. Right antapical horn about 3 to 4 times longer than left one, arises immediately behind the cingulum and bends laterally-anteriorly. Left antapical horn very short and bends laterally. Widest point adjacent to the antapical horns. L 152-290 μm ($238.8 \pm 36.5 \mu\text{m}$), Wb 64-83 μm ($74.4 \pm 4.4 \mu\text{m}$), Wt 190-265 μm ($232.0 \pm 19.5 \mu\text{m}$); n=20. Chains of 2 to 6 cells were observed.

Note: *C. dens* has been previously reported for the Gulf of Mexico only for West Florida waters (Steidinger et al., 2009), and thus it is a new record for the Mexican part of the Gulf. *C. dens* was also found in samples taken in 2009 near the northern coast of the Yucatan Peninsula (Okolodkov, unpubl.; F. del C. Merino-Virgilio, pers. comm.). The taxon presented by Balech (1988) for the SW Atlantic and by Licea et al. (1995) for the Mexican Pacific under the name of *Ceratium dens* is another species described later, *Ceratium balechii* Meave, Zamudio et Okolodkov (Meave del Castillo et al., 2003). The latter is conspecific with the taxon found in Ecuadorian waters under the name of *C. tripos* var. *poncticum* Jörg. (Pesantes-Santana, 1978: 19, pl. 13, fig. 3, 4) and in the Sea of Japan under the name of *C. dens* (Konovalova, 1998: 151, fig. 29(11)).

Records in the State of Veracruz: A new record for the State of Veracruz. Rare in NPSAV (Feb., March, Sep., Nov., Dec.).

References: Karsten, 1907*: pl. 48, fig. 8a, b; Jörgensen, 1911*: 31, fig. 58, Böhm, 1931b*: 15, fig. 11a-e; Steemann Nielsen, 1934*: 15, fig. 27; Schiller, 1937*: 381, fig. 420a, b; Wood, 1954*: 284, fig. 204; Sournia, 1968*: 457, fig. 80; Subrahmanyam, 1968*: 34, fig. 58, pl. 3, fig. 16; Hassan, 1976*: 287, fig. 1; Taylor, 1976*: 68, pl. 17, fig. 172; Dowidar, 1983*: 17, pl. 6, fig. 3; Gárate-Lizárraga, 2009** ***: 167, fig. 1-11, 13-17; Yongshui, 2009** ***: pl. 2, fig. 10, pl. 11, fig. 1A, B.

15. *Ceratium ranipes* Cleve, 1900 (Pl. 4, Fig. 1 and 2; Pl. 11, Fig. 3)

Cell body subtrapezoidal, with convex epitheca. Posterior membrane supported with strong spines. Right antapical horn arises immediately behind the cingulum. Antapical horns are directed anteriorly and are terminated with finger-shaped appendages. Widest point adjacent to the antapical horns. L 270 μm , Wb 55 μm , Wt 128 μm ; n=1.

Records in the State of Veracruz: Figueroa-Torres, 1990*. Extremely rare in NPSAV (the only specimen observed was collected on 14 February 2006 at st. 4).

References: Karsten, 1907*: pl. 50, fig. 6, 7 (as *C. palmatum* Br. Schröder); Jörgensen, 1920*: 82, fig. 76; Böhm, 1931b*: 31, fig. 28-31; Paulsen, 1931*: 86, fig. 53A-C; Steemann Nielsen, 1934*: 24, fig. 58; Schiller, 1937*: 409, fig. 451a; Rampi, 1939*: 307, fig. 2 (*C. ranipes* Cleve f. *palmatum* (Schröder) Jörgensen); Graham & Bronikovsky, 1944*: 37, fig. 19I-K, 20, 21A; Wood, 1954*: 299, fig. 227; 1968*: 38, fig. 84; López, 1966*: fig. 19, 20, Sournia, 1968*: 459, fig. 81, 82; Subrahmanyam, 1968*: 60, fig. 110; Steidinger & Williams, 1970***: 47, pl. 13, fig. 33; Taylor, 1976*: 77, pl. 19, fig. 189-192; Trégouboff, 1978*: 115, pl. 26, fig. 10; Tester & Steidinger, 1979***: 29, pl. 12, fig. 71 (*C. ranipes* var. *palmatum* (Schröder) Cleve); Dowidar, 1983*: 17, pl. 5, fig. 5; Balech, 1988*: 142, pl. 60, fig. 8, 9, pl. 61, fig. 1; Delgado & Fortuño, 1991*: fig. 7H; Licea et al., 1995*: 46, pl. 20, fig. 1; Konovalova, 1998*: 148, fig. 30(12); Avancini et al., 2006* **: 297, fig. A-D; Yongshui, 2009* ** ***: 53, fig. 61-63, pl. 4, fig. 2, 3A, B, pl. 14, fig. 2, 3 (three infraspecific taxa are illustrated).

16. *Ceratium limulus* Gourret, 1883 (Pl. 4, Fig. 3; Pl. 11, Fig. 4)

Cell body very robust, subquadrangular, with characteristic “shoulders”, squared margins in the anterior part of the cell body, just near the base of the apical horn. Posterior margin of the cell is very convex. Apical horn very short and straight,

well separated from the cell body, positioned centrally. Proximal parts of the antapical horns, which are also short, are directed laterally-forward; distally they bend, and both horns are situated very close to the cell body (the right antapical horn is attached to it) and are directed forward, finally becoming convergent. Widest point adjacent to the cingulum. L 95-112.5 μm ($103.8 \pm 12.4 \mu\text{m}$), Wb 55-57.5 μm ($56.3 \pm 1.8 \mu\text{m}$), Wt 84-85 μm ($84.5 \pm 0.7 \mu\text{m}$); n=2.

Records in the State of Veracruz: Figueroa-Torres, 1990*. Extremely rare in NPSAV (the only two specimens observed were collected on 27 December 2005 and on 29 January 2008 relatively far from the shore, at sts. 2 and 8).

References: Jörgensen, 1911*: 57, fig. 122; 1920*: 77, fig. 72; Böhm, 1931a*: 361, fig. 13, 14; 1931b*: 31, fig. 27b; Steemann Nielsen, 1934*: 24, fig. 45; Schiller, 1937*: 407, fig. 448a-c; Rampi, 1939*: 307, fig. 19; Graham & Bronikovsky, 1944*: 35, fig. 19A; Kato, 1957*: 17, pl. 5, fig. 15; Sournia, 1968**: 458, pl. 1, fig. 5; Subrahmanyam, 1968*: 56, fig. 103-105; Wood, 1968*: 34, fig. 71; Trégouboff, 1978*: 115, pl. 26, fig. 7; Delgado & Fortuño, 1991***: 6, pl. 6, fig. c, d; Licea et al., 1995**: 41, pl. 3, fig. 7; Steidinger & Tangen, 1997*: 475, pl. 28; Konovalova, 1998*: 141, fig. 34(1); Avancini et al., 2006* **: 291, fig. A-F; Yongshui, 2009* ** ***: 71, fig. 82, pl. 6, fig. 6, pl. 17, fig. 3.

17. *Ceratium gibberum* Gourret, 1883 var. *dispar* (Pouchet) Sournia, 1966 (Pl. 4, Fig. 4; Pl. 11, Fig. 5)

Syn.: *Ceratium tripos* var. *megaceras* Pouchet, 1883: 421, fig. C.

Cell body very robust, subpentagonal. Posterior margin of the cell is very convex. Epitheca is low. Apical horn moderately long and straight, strongly shifted to the left. Proximal part of the left antapical horn is directed laterally-forward and that of the right antapical horn is directed much more forward than laterally and then perpendicularly to the apical horn, just in front of the epitheca. Widest point adjacent to the cingulum. L 132-270 μm ($201.0 \pm 97.6 \mu\text{m}$), Wb 85-92 μm ($88.5 \pm 4.9 \mu\text{m}$), Wt 142-148 μm ($145.0 \pm 4.2 \mu\text{m}$); n=2.

Records in the State of Veracruz: Figueroa-Torres, 1990*; García-Reséndiz, 2003. Extremely rare in NPSAV (only two specimens were observed, those collected on 7 June 2005 and on 11 December 2007 at sts. 2 and 3).

References: Paulsen, 1908*: 75, fig. 98; Jörgensen, 1911*: 49, fig. 106, 107, 109; 1920*: 70, fig. 67, 68; Lebour, 1925*: 152, fig. 49; Steemann Nielsen, 1934*: 22, fig. 48; Schiller, 1937*: 397, fig. 436a, b; Rampi, 1939*: 306, fig. 24; Graham & Bronikovsky, 1944*: 33, fig. 17D-G; Kiselev, 1950*: 250, fig. 437; Wood, 1954*: 290,

fig. 214a, b;); 1968*: 30, fig. 61; Kato, 1957*: 16, pl. 5, fig. 17; Curl, 1959*: 306, fig. 117 (*C. gibberum*); López, 1966*: fig. 23 (*C. gibberum*); Sournia, 1968*: 446, fig. 73, 74 (two varieties are illustrated); Subrahmanyam, 1968*: 46, fig. 76-78; Steidinger & Williams, 1970**: 45, pl. 8, fig. 22; Hassan, 1976*: 289, fig. 7; Taylor, 1976*: 84, pl. 19, fig. 187; Pesantes-Santana, 1978*: 12, pl. 9, fig. 1; Dodge, 1982*: 235, fig. 30F (*C. giberrum*); Delgado & Fortuño, 1991***: 6, pl. 6, fig. a, b; Licea et al., 1995*: 38, pl. 18, fig. 7; Steidinger & Tangen, 1997*: 472, pl. 27 (*C. gibberum*); Yongshui, 2009* ** ***: 69, fig. 80, pl. 6, fig. 5, pl. 17, fig. 1.

18. *Ceratium vultur* Cleve, 1900 f. *vultur* (Pl. 4, Fig. 5 and 6; Pl. 8, Fig. 7; Pl. 9, Fig. 7; Pl. 11, Fig. 6)

Syn.: *Ceratium sumatranum* (G. Karst.) Jörg., 1911 (incl. f. *angulatum* Jörg.): 73, fig. 154, 155, non 153.

Cell body very robust, somewhat trapezoidal. Theca strongly sculptured, with posterior membrane and membranes on the horns. Apical horn in the anterior cell of the colony thicker and longer than those in other cells. Right antapical horn bends laterally-anteriorly, arising immediately behind the cingulum. Widest point adjacent to the antapical horns. L 110-400 μm ($182\pm 116.3 \mu\text{m}$), Wb 57.5-62.5 μm ($59.3\pm 1.9 \mu\text{m}$), Wt 160-410 μm ($280\pm 56.9 \mu\text{m}$); n=22. Chains of 2 to 5 cells were observed.

Note: Three infraspecific taxa have been found for the Gulf of Mexico (Steidinger et al., 2009).

Records in the State of Veracruz: Avendaño-Sánchez & Sotomayor-Navarro, 1982; Figueroa-Torres, 1990* **; Zamudio-Resendiz, 1998 (two forms were distinguished without their identification); Aquino-Cruz, 2002** (the cell illustrated in fig. 10 as *Ceratium* sp. is most likely *C. vultur*, judging from the proximal parts of the antapical horns). Extremely rare in NPSAV (March, Dec.).

References: Ostenfeld & Schmidt, 1901*: 167, fig. 20; Karsten, 1907*: pl. 48, fig. 13-15 (also as *C. tripos robustum* Ostf. u. Schm.); Dangeard, 1927*: 378, fig. 42b, c (as *C. vultur* Cleve and *C. sumatranum* Karsten); Böhm, 1931b*: 38, fig. 35b, c, pl. 1 (*C. vultur* and *C. sumatranum*); Steemann Nielsen, 1934*: 27, fig. 65, non 66; Schiller, 1937*: 418, fig. 459a, b; Graham & Bronikovsky, 1944*: 41, fig. 23A-H; Wood, 1954*: 304, fig. 233a; 1968*: 41, fig. 94; Kato, 1957*: 19, pl. 7, fig. 24 (*C. sumatranum* f. *angulatum*); Sournia, 1968*: 480, fig. 96, 97 (four forms are given); Subrahmanyam, 1968*: 68, fig. 131; Steidinger & Williams, 1970**: 47, pl. 15, fig. 39 (*C. vultur* var. *sumatranum*); Hassan, 1976*: 291, fig. 15a, b (*C. vultur* var. *sumatranum*); Taylor, 1976* ***: 76, pl. 22, fig. 220-224, pl. 43, fig. 511 (five infraspecific

taxa are illustrated); Pesantes-Santana, 1978*: 19, pl. 10, fig. 1, 2 (*Ceratium vultur* var. *sumatranum* (Karsten) Steemann Nielsen); Tester & Steidinger, 1979**: 28, pl. 11, fig. 73a, b; Dowidar, 1983*: 20, pl. 6, fig. 5; Steidinger & Tangen, 1997*: 482, pl. 6, 28; Balech, 1988*: 151, pl. 67, fig. 1-4; Licea et al., 1995*: pl. 5, fig. 8 (f. *sumatranum*), pl. 20, fig. 5 (var. *vultur*); Konovalova, 1998*: 163, fig. 34(3-5) (three infraspecific taxa are illustrated); Yongshui, 2009* ** ***: 49, fig. 57-60, pl. 4, fig. 1A, B, pl. 13, fig. 3, 4, pl. 14, fig. 1A, B (four infraspecific taxa are illustrated).

19. ***Ceratium lunula* (Schimper ex G. Karst.) Jörg., 1911** (Pl. 4, Fig. 7; Pl. 11, Fig. 7)
Bas.: *Ceratium tripos lunula* Schimper ex G. Karst., 1906 (Wiss. Ergebn. der Deutschen Tiefsee-Expedition auf dem Valdivia 1898-1899 2, 2, 2): 142, pl. 20, fig. 12, non al.

Cell body very robust, almost triangular, lacking a notch between the antapical horns. Posterior margin of the cell slightly flat. Apical horn straight, from short to long, positioned centrally, slightly inclined to the right. Antapical horns are long, directed laterally at their bases and then bent anteriorly so that in general they are parallel to each other or slightly convergent. Widest point adjacent to the antapical horns. L 350-470 μm ($425.0 \pm 65.4 \mu\text{m}$), Wb 82.5-85 μm ($84.2 \pm 1.4 \mu\text{m}$), Wt 320-330 μm ($323 \pm 5.8 \mu\text{m}$); n=3.

Records in the State of Veracruz: Figueroa-Torres, 1990* **. Extremely rare in NPSAV (Nov., Dec.).

References: Jörgensen, 1911*: 51, fig. 112-115; 1920*: 74, fig. 70; Böhm, 1931b*: 30, fig. 26; Steemann Nielsen, 1934*: 23, fig. 50; Schiller, 1937*: 399, fig. 439a, b; Graham & Bronikovsky, 1944*: 33, fig. 17J-N; Wood, 1954*: 291, fig. 215a, b; 1968*: 35, fig. 76; Silva, 1956*: 61, pl. 8, fig. 3-5; Sournia, 1968*: 450, fig. 75, 76; Subrahmanyam, 1968*: 49, fig. 82-87, pl. 3, fig. 19, pl. 7, fig. 33; Steidinger & Williams, 1970**: 46, pl. 10, fig. 28; Hassan, 1976*: 289, fig. 8; Taylor, 1976*: 85, pl. 16, fig. 171, pl. 18, fig. 183 (two varieties are illustrated); Pesantes-Santana, 1978*: 14, pl. 10, fig. 3; Delgado & Fortuño, 1991*: fig. 6M; Licea et al., 1995*: 42, pl. 19, fig. 5, non pl. 3, fig. 10 (the illustrated specimen is a misidentification; most likely it is *C. tripos* var. *breve*); Steidinger & Tangen, 1997*: 475, pl. 29; 150, fig. 29(10); Yongshui, 2009* **: 73, fig. 85, pl. 6, fig. 8.

20. ***Ceratium contortum* (Gourret) Cleve, 1900** (Pl. 4, Fig. 8; Pl. 5, Fig. 1; Pl. 8, Fig. 6; Pl. 11, Fig. 8; Pl. 12, Fig. 1)
Bas.: *Ceratium giberrum* var. *contortum* Gourret, 1883: 35, pl. 2(33).

Syn.: *Ceratium longinum* (G. Karst.) Jörg., 1911 (Intern. Rev. d. ges. Hydrob. u. Hydrog. 4, Suppl.-Heft, 1): 54, fig. 119a, b.

Cell body subtriangular, with slightly convex posterior margin, lacking a notch between the antapical horns. Apical horn very long, emerges from the left half of the cell body, is directed anteriorly at its base and then bends to the right. Right horn twisted, with its distal part directed to the left in var. *saltans* (Pl. 5, Fig. 1; Pl. 12, Fig. 1) or it is S-shaped and directed anteriorly in var. *contortum* (Pl. 4, Fig. 8; Pl. 11, Fig. 8). Widest point adjacent to the antapical horns. L 232-740 μm ($417.6 \pm 112.7 \mu\text{m}$), Wb 52-85 μm ($72.7 \pm 5.8 \mu\text{m}$), Wt 182-250 μm ($210.4 \pm 16.1 \mu\text{m}$); n=25.

Note: Four varieties and one form of this species have been reported for the Gulf of Mexico (Steidinger et al., 2009).

Records in the State of Veracruz: Avendaño-Sánchez & Sotomayor-Navarro, 1982 (also as *C. longinum*); Figueroa-Torres, 1990* **; Zamudio-Resendiz, 1998; García-Reséndiz, 2003. Common in NPSAV (March to Dec.).

References: Jörgensen, 1911*: 55, fig. 120; Böhm, 1931b*: 23, fig. 20a-c (*C. contortum* var. *saltans*); Steemann Nielsen, 1934*: 23, fig. 52, 53; Schiller, 1937*: 395, fig. 433; Graham & Bronikovsky, 1944*: 34, fig. 18D-N; Silva, 1952b*: 604, pl. 6, fig. 10; 1956*: 61, pl. 8, fig. 2; Sournia, 1968* **: 441, fig. 67-70 (non 71, 72), pl. 2, fig. 9; Subrahmanyam, 1968*: 44, fig. 69-71; Wood, 1968*: 23, fig. 39 (the specimen illustrated as *Ceratium azoricum* is a misidentification and appears to be *C. contortum*), 26, fig. 48; Steidinger & Williams, 1970**: 44, pl. 6, fig. 16a, b; Taylor, 1976*: 81, pl. 18, fig. 179-181 (three infraspecific taxa are illustrated), non 184; Trégouboff, 1978*: 115, pl. 26, fig. 2; Tester & Steidinger, 1979**: 28, pl. 10, fig. 60; Balech, 1988*: 145, pl. 62, fig. 4, pl. 63, fig. 2; Hernández-Becerril, 1988**: 190, pl. 1, fig. 5 (*C. contortum* var. *subcontortum* (Schröder) Taylor, 1976); Licea et al., 1995**: 33, pl. 2, fig. 1; 2004**: fig. 19; Steidinger & Tangen, 1997*: 472, pl. 27; Konovalova, 1998*: 152, fig. 32(2, 6) (also as *C. longinum* Karst.); Yongshui, 2009* ** ***: 64, fig. 73, 75, 76, pl. 6, fig. 1A, B, 2, pl. 16, fig. 2, 3A, B (three infraspecific taxa are illustrated), 72, fig. 84 (as *C. longinum*).

21. *Ceratium karstenii* Pavillard, 1907 (Pl. 5, Fig. 2; Pl. 12, Fig. 2)

Syn.: *Ceratium arcuatum* Cleve, 1900: 13, pl. 7, fig. 11; *Ceratium contortum* var. *karstenii* (Pavillard) Sournia, 1966: 1981.

Cell body robust, subtriangular, with slightly convex posterior margin, lacking a notch between the antapical horns, longer than wide. Apical horn very long, somewhat curved at its base. Antapical horns are directed anteriorly. Widest point

adjacent to the antapical horns. L 410-723 μm ($508.5\pm 89.7 \mu\text{m}$), Wb 75-93.5 μm ($85.6\pm 4.8 \mu\text{m}$), Wt 220-460 μm ($284\pm 47.9 \mu\text{m}$); n=25.

Affinities: The species is similar to *C. contortum*, and some authors consider them conspecific. According to Balech (1988), *C. karstenii* is distinguished from the latter by a more robust and wider cell body and the absence of torsion in the right antapical horn.

Note: Licea et al. (2004) consider this dinoflagellate species one of the 30 most common in the Gulf of Mexico; however, it is rare in Veracruz waters, including NPSAV (Feb., March, Apr., June, July, Nov., Dec.).

References: Karsten, 1907*: pl. 48, fig. 4, 6a-c (as *C. arcuatum* Gourret, *C. arcuatum* var. *robusta* n. var. and *C. tripos Schrankii* Kofoid); Jörgensen, 1911*: 53, fig. 116, 117; 1920*: 75, fig. 71; Böhm, 1931b*: 26, fig. 23-25 (*C. arcuatum* var. *robustum*); Paulsen, 1931*: 84, fig. 52A-C; Steemann Nielsen, 1934*: 23, fig. 51; Schiller, 1937*: 393, fig. 431a, b; Rampi, 1939*: 306, fig. 18; Kiselev, 1950*: 249, fig. 463, 512; Wood, 1954*: 289, fig. 211a, b; 1968*: 33, fig. 68; Silva, 1956*: 56, pl. 7, fig. 9; Sournia, 1968* **: 442, fig. 71, 72, pl. 3, fig. 10 (as *C. contortum* var. *robustum* and *C. contortum* var. *Karstenii*); Subrahmanyam, 1968*: 42, fig. 67, 68; Steidinger & Williams, 1970***: 45, pl. 6, fig. 17a, pl. 7, fig. 17b; Hassan, 1976*: 289, fig. 6 (as *C. contortum* var. *karstenii*); Taylor, 1976*: 82, pl. 18, fig. 184; Pesantes-Santana, 1978*: 8, pl. 5, fig. 3, 4 (as *C. contortum* var. *karstenii*; with an orthographic error in the name of the variety); Trégouboff, 1978*: 116, pl. 25, fig. 16; Dowidar, 1983*: 16, pl. 4, fig. 6; Balech, 1988*: 144, pl. 62, fig. 3, pl. 63, fig. 1, 6; Delgado & Fortuño, 1991*: fig. 7F; Licea et al., 1995***: 33, pl. 2, fig. 2 (as *C. contortum* var. *karstenii*); Konovalova, 1998*: 151, fig. 29 (f. *karstenii* and f. *robustum* (Karst.) Jörg.); Yongs-hui, 2009* **: 65, fig. 74, pl. 5, fig. 7.

22. *Ceratium euarcuatum* Jörg., 1920 (Pl. 5, Fig. 3; Pl. 12, Fig. 3)

Cell body delicate, subtriangular, longer than it is wide. Posterior margin of the cell is convex, very oblique in relation to the apical horn. Apical horn rather long, slightly curved, positioned centrally. Proximal part of left antapical horn is directed laterally, and that of the right horn is directed laterally-forward; distally they bend continuously and are directed anteriorly, being slightly convergent. Widest point adjacent to the cingulum or to the antapical horns. L 180-285 μm ($226.6\pm 28.8 \mu\text{m}$), Wb 47.5-56.5 μm ($52.8\pm 3.0 \mu\text{m}$), Wt 113-250 ($153.2\pm 27.1 \mu\text{m}$); n=28.

Affinities: The species is distinguished from *C. symmetricum* by the very oblique posterior margin of the cell.

Records in the State of Veracruz: Figueroa-Torres, 1990* **. Rare in NPSAV (March to Aug., Dec.)

References: Jörgensen, 1920*: 56, fig. 54; Steemann Nielsen, 1934*: 18, fig. 38; Schiller, 1937*: 402, fig. 443; Rampi, 1939*: 306, fig. 30; Graham & Bronikovskiy, 1944*: 28, fig. 15M, N; Wood, 1954*: 294, fig. 220; 1968*: 28, fig. 53; Margalef, 1961b*: 140, fig. 3/7; López, 1966*: fig. 31; Sournia, 1968*: 436, fig. 64, 65; Subrahmanyam, 1968*: 53, fig. 94; Taylor, 1976*: 83, pl. 15, fig. 155, 157, 159; Pesantes-Santana, 1978*: 9, pl. 5, fig. 1, 2; Licea et al., 1995**: 35, pl. 2, fig. 5; Yongshui, 2009*: 69, fig. 79, pl. 6, fig. 4.

23. *Ceratium tripos* (O. F. Müll.) Nitzsch, 1817 (Pl. 5, Fig. 4-6; Pl. 7, Fig. 3; Pl. 8, Fig. 3 and 8; Pl. 9, Fig. 8; Pl. 12, Fig. 4-6)

Bas.: *Cercaria tripos* O. F. Müller, 1777: 206; 1786: 136, pl. 19(22).

Cell body subtriangular, its length is equal to or slightly exceeds its width, lacking a notch between the antapical horns. Posterior margin of the cell slightly convex. Apical horn straight, from short to long, positioned subcentrally, slightly inclined to the right. Antapical horns rather short, directed laterally at their bases and then bent anteriorly. Widest point adjacent to the antapical horns. Chains of 2 to 3 cells were observed.

Note: Five varieties and one form have been reported for the Gulf of Mexico (Steidinger et al., 2009). Microgametes 72-77 μm long and 37-40 μm wide, formed by depauperating divisions (sometimes called degenerate forms in the old literature), presumably belonging to *C. tripos* (see Hoppenrath et al., 2009: fig. 71f-h), were observed twice (Pl. 7, Fig. 3). A teratologic cell with a peculiar apical horn was found.

Records in the State of Veracruz: Avendaño-Sánchez & Sotomayor-Navarro, 1982; Figueroa-Torres, 1990* **; Estradas-Romero, 2004 (as *C. pentagonum* var. *atlanticus*); Tejeda-Hernández, 2005** (as *C. tripos tripodoides*; the specimen in the photograph does not correspond to var. *tripodoides*). Very common in NPSAV, throughout the year.

References: Ostefeld, 1903*: 583, fig. 132-134 (two forms are illustrated); Paulsen, 1907*: 21, fig. 30, 31 (two forms are illustrated); 1908*: 77, fig. 102-107; 1931*: 78, fig. 47A-F; Jörgensen, 1911*: 35, fig. 1, 2, 65-79; 1920*: 46, fig. 33-39 (*C. tripos*), 40-53 (*C. pulchellum*); Lebour, 1925*: 148, fig. 32, 33; Wailes, 1928*: 5, pl. 1, fig. 4, pl. 3, fig. 1 (as *C. tripos* var. *atlantica*); Böhm, 1931a*: 356, fig. 7-10, 33-35 (six taxa are illustrated including three new forms); 1931b*: 15, fig. 12-16 (*C. tripos* and

C. pulchellum), 38 (*C. pulchellum* var. *indicum* n. var.); Steemann Nielsen, 1934*: 17, fig. 32, 33; Schiller, 1937*: 382, fig. 383, 385; Schiller, 1937*: 401, fig. 441a-d; Graham & Bronikovsky, 1944*: 25, fig. 13E-N, 14B-F; Kiselev, 1950*: 246, fig. 428, 431, 432, 440, 442; Kato, 1957*: 15, pl. 4, fig. 12a, b, 13a, b (*C. tripos* and *C. tripos* f. *neglecta* (Ostenfeld) Paulsen); Curl, 1959*: 306, fig. 121, 123 (*C. tripos* var. *atlanticum* Ostenfeld and *C. pulchellum* Schroeder); Margalef, 1961a*: 81, fig. 26j, pl. 6, 7; López, 1966* **: fig. 33-36, photo 2(1-3) (four infraspecific taxa are illustrated); Subrahmanyam, 1968*: 35, fig. 59, pl. 3, fig. 17, 18; Wood, 1968*: 41, fig. 92, 93 (also as *C. tripos* var. *pulchellum* (Schröder) nov. comb.); Hermosilla, 1973*: 65, pl. 33, fig. 5; Drebes, 1974** *: 148, fig. 130; Hassan, 1976*: 287, fig. 2 (*C. tripos* var. *atlanticum*); Taylor, 1976*: 88, pl. 14, fig. 147, 149-151, pl. 16, fig. 168-170; Trégouboff, 1978*: 116, pl. 25, fig. 14A, B; Burns & Mitchell, 1982***: 64, fig. 17-22 (three infraspecific taxa are figured); Dodge, 1982*: 234, fig. 30A-D; Dowidar, 1983*: 13, pl. 2, fig. 9; Balech, 1988*: 138, pl. 58, fig. 1-7, pl. 59, fig. 1-6, pl. 60, fig. 1, 2; Konovalova et al., 1989* ***: 136, fig. 51(1), pl. 23, fig. 6-8 (var. *balticum* Schütt); Steidinger & Williams, 1970** *: 47, pl. 15, fig. 40 (?) (as *Ceratium* sp.); Delgado & Fortuño, 1991* ***: fig. 7C; 6, pl. 3, fig. c, d; Licea et al., 1995* **: 48, pl. 5, fig. 5a, b, 7, pl. 20, fig. 4 (the taxon given as *C. tripos* var. *ponticum* Jörgensen in pl. 5, fig. 6a-c, is *C. balechii*; see the note to *C. dens*); 2004** *: fig. 22; Wiktor & Okolodkov, 1995*: 44, fig. 14a, b; Steidinger & Tangen, 1997*: 478, pl. 26; Konovalova, 1998* ***: 142, fig. 30(2, 4-6, 8), 31(5), pl. 13, fig. 3, 4 (five infraspecific taxa are illustrated); Bérard-Therriault et al., 1999** *: 165, pl. 82b (*C. tripos* var. *atlanticum* Ostenfeld, 1903); Avancini et al., 2006* **: 303, fig. A, B; 295, fig. A, B (*C. pulchellum*); Hoppenrath et al., 2009** ***: 175, fig. 71a-l; Yongshui, 2009* ** ***: 77, fig. 89-92, pl. 7, fig. 3-6, pl. 18, fig. 1-3 (four infraspecific taxa are illustrated).

var. *tripos* (Pl. 5, Fig. 4; Pl. 8, Fig. 8; Pl. 12, Fig. 4)

Cell body is as long as wide, without a depression between the posterior margin of the cell body and the right antapical horn. L 120-248 μm ($192.5 \pm 42.7 \mu\text{m}$), Wb 66-83 μm ($74.2 \pm 5.0 \mu\text{m}$), Wt 150-200 μm ($168.6 \pm 13.0 \mu\text{m}$); n=25.

Records in the State of Veracruz: Ochoa-Figueroa, 1978 (as *Ceratium tripos*); Hernández-Mendiola, 1988 (as *C. tripos*); Suchil-Vilchis, 1990* (as *C. tripos*); Zamudio-Resendiz, 1998 (var. *tripos* and var. *pulchellum*).

References: Balech, 1988*: 139, fig. 1-6; Yongshui, 2009* **: 77, fig. 89, pl. 7, fig. 3.

var. *breve* Ostenf. et J. Schmidt, 1901 (Pl. 5, Fig. 5; Pl. 12, Fig. 5)

Syn.: *Ceratium breve* (Ostenf. et J. Schmidt) Schröder, 1906: 358.

Cell body is as long as wide, larger than in other varieties, without a depression between the posterior margin of the cell body and the right antapical horn. L 125 μm , Wb 83-88 μm ($85.3 \pm 3.2 \mu\text{m}$), Wt 145-175 μm ($160 \pm 21.2 \mu\text{m}$); n=2.

Records in the State of Veracruz: Avendaño-Sánchez & Sotomayor-Navarro, 1982; Figueroa-Torres, 1990* **; Zamudio-Resendiz, 1998; Aquino-Cruz, 2002***: fig. 2, non pl.1, fig. 2 (a very schematic line drawing in pl. 1 is more similar to *C. symmetricum* var. *symetricum* than to *C. tripos* var. *breve*); Tejeda-Hernández, 2005**.

References: Jörgensen, 1911*: 40, fig. 84; Böhm, 1931b*: 18, fig. 17, 18; Steemann Nielsen, 1934*: 18, fig. 35, 36; Schiller, 1937*: 391, fig. 429a, b; Graham & Bronikovsky, 1944*: 27, fig. 14G-P; Wood, 1954*: 288, fig. 209a, b; 1968*: 24, fig. 42; Schiller, 1937*: 401, fig. 441a-d; Sournia, 1968* **: 416, fig. 40-45, pl. 2, fig. 7 (seven infraspecific taxa are indicated); Subrahmanyam, 1968*: 40, fig. 62, 63, pl. 3, fig. 13-15; Steidinger & Williams, 1970***: 47, pl. 14, fig. 37a, pl. 15, fig. 38a, b (var. *atlanticum* and var. *ponticum*); Hassan, 1976*: 287, fig. 3, 4 (*C. breve* var. *parallelum*); Taylor, 1976*: 80, pl. 14, fig. 141, 142, 146; Pesantes-Santana, 1978*: 7, pl. 3, fig. 3, 4; Burns & Mitchell, 1982***: 60, fig. 6-10; Dowidar, 1983*: 13, pl. 2, fig. 10, pl. 3, fig. 12; Balech, 1988*: 140, pl. 60, fig. 1, 2; Hernández-Becerril, 1988***: 188, pl. 1, fig. 6; Konovalova, 1998*: 146, fig. 30(5); Licea et al., 2004***: fig. 9; Yongshui, 2009* ** ***: 61, fig. 69, pl. 5, fig. 4, pl. 15, fig. 3 (as *C. breve* var. *breve*).

f. *tripodoides* Jörg., 1920 emend. Paulsen, 1931 (Pl. 5, Fig. 6; Pl. 8, Fig. 3; Pl. 12, Fig. 6)

Syn.: *Ceratium tripodoides* (Jörg.) Ostenf. et J. Schmidt, 1901: 15, fig. 28; *Ceratium pulchellum* f. *tripodoides* Jörg., 1920: 50, fig. 41, 42, 45; *Ceratium tripos* var. *tripodoides* (Jörg.) Paulsen, 1931: 78, fig. 47.

Cell body slightly longer than wide, with a shallow depression between the posterior margin of the cell body and the right antapical horn. L 138-346 μm ($276.1 \pm 40.3 \mu\text{m}$), Wb 60-71 μm ($65.5 \pm 4.5 \mu\text{m}$), Wt 145-203 μm ($172.9 \pm 15.0 \mu\text{m}$); n=21.

Note: This variety is reported here for the first time for the Gulf of Mexico. Var. *tripodoides* and var. *atlanticum* (Ostenf.) Paulsen are very similar (Sournia, 1968: 419), and are likely to be synonyms.

References: Paulsen, 1931*: 78, fig. 47A-F; López, 1966*: fig. 34; Pesantes-Santana, 1978*: 18, fig. pl. 12, fig. 5 (as *Ceratium tripos* var. *tripoides*); Konovalova, 1998*: 144, fig. 30(4); Yongshui, 2009* ***: 81, fig. 93, pl. 18, fig. 3 (as *C. tripodoides*).

24. *Ceratium azoricum* Cleve, 1900 (Pl. 5, Fig. 7; Pl. 12, Fig. 7)

Cell body subglobular, with convex posterior margin, lacking a notch between the antapical horns. Apical horn very short, positioned centrally. Antapical horns relatively short, continuously curved and directed anteriorly. Right antapical horn is positioned very close to the cell body. Widest point adjacent to the antapical horns. L 90-115 μm ($100.7 \pm 7.1 \mu\text{m}$), Wb 42.5-50 ($45.1 \pm 2.3 \mu\text{m}$), Wt 56-92.5 μm ($77.0 \pm 9.4 \mu\text{m}$); n=21.

Records in the State of Veracruz: Figueroa-Torres, 1990*. Rare to common in NPSAV (Feb., March, July, Aug., Nov., Dec.).

References: Karsten, 1907*: pl. 48, fig. 1a, b; Paulsen, 1908*: 76, fig. 99; Jörgensen, 1911*: 47, fig. 97, 98; 1920*: 69, fig. 66; Lebour, 1925*: 151, fig. 48; Wailes, 1928*: 5, pl. 1, fig. 3; Steemann Nielsen, 1934*: 20, fig. 43; Schiller, 1937*: 406, fig. 447; Rampi, 1939*: 307, fig. 25; Graham & Bronikovsky, 1944*: 30, fig. 16M-P; Kiselev, 1950*: 252, fig. 413; Wood, 1954*: 295, fig. 222a, b; López, 1966*: fig. 26; Sournia, 1968*: 435, fig. 58; Subrahmanyan, 1968*: 56, fig. 102; Hermosilla, 1973*: 67, pl. 36, fig. 1-4; Hassan, 1976*: 289, fig. 5; Taylor, 1976*: 79, pl. 15, fig. 160; Pesantes-Santana, 1978*: 7, pl. 2, fig. 4, 5; Trégouboff, 1978*: 115, pl. 26, fig. 6; Burns & Mitchell, 1982***: 57, fig. 5 (the specimens illustrated in fig. 2 and 3 as *C. arietinum* most likely belong to *C. azoricum*); Dodge, 1982*: 232, fig. 29F; Dowidar, 1983*: 14, pl. 4, fig. 7; Balech, 1988*: 137, pl. 57, fig. 6; Licea et al., 1995**: 30, pl. 1, fig. 4; Konovalova, 1998*: 142, fig. 29(13); Yongshui, 2009* **: 60, fig. 68, pl. 5, fig. 3.

25. *Ceratium arietinum* Cleve, 1900 var. *gracilentum* (Jörg.) Sournia, 1966 (Pl. 5, Fig. 8; Pl. 12, Fig. 8)

Cell body rather delicate, with notably convex posterior margin, lacking a notch between the antapical horns. Apical horn short or moderately long, slightly curved at its base and distally straight, emerging from the left half of the cell body. Antapical horns are positioned at subequal distance from the cell body. Their proximal parts are directed laterally, distally they bend continuously, forming a semi-circle. The distal part of the right antapical horn is perpendicular to the apical horn. Widest region adjacent to the antapical horns, also occupying the distal half of the cell body on the left side. L 140-243 μm ($182.2 \pm 45.2 \mu\text{m}$), Wb 52.5-55 μm ($54.2 \pm 1.3 \mu\text{m}$), Wt 140-163 μm ($152 \pm 9.5 \mu\text{m}$); n=6.

Affinities: *C. declinatum* (see the notes to *C. declinatum*).

Note: The species has been repeatedly reported for the Gulf of Mexico (Steidinger et al., 2009).

Records in the State of Veracruz: Figueroa-Torres, 1990* **; Zamudio-Resendiz, 1998. Extremely rare in NPSAV (Jan., March, May, July, Aug., Dec.).

References: Karsten, 1907*: pl. 48, fig. 3; Jörgensen, 1911*: 48, fig. 102-105; 1920*: 62, fig. 60-62; Steemann Nielsen, 1934*: 21, fig. 45; Schiller, 1937*: 403, fig. 414; Rampi, 1939*: 307, fig. 28; Graham & Bronikovsky, 1944*: 31, fig. 16A-K; Kiselev, 1950*: 252, fig. 420; Wood, 1954*: 294, fig. 221a; 1968*: 23, fig. 37; Kato, 1957*: 16, pl. 6, fig. 21, 22 (including *C. bucephalum* var. *heterocamptum* Jörgensen); López, 1966*: fig. 27; Sournia, 1968*: 429, fig. 51, 52, 54 (three varieties are illustrated); Subrahmanyan, 1968*: 54, fig. 95-97; Taylor, 1976*: 78, pl. 16, fig. 162, 165; Trégouboff, 1978*: 115, pl. 26, fig. 4; Burns & Mitchell, 1982***: 57, fig. 4, non 2, 3 (the specimens illustrated in fig. 2 and 3 are likely misidentifications, and they correspond well to *C. azoricum*); Dowidar, 1983*: 14, pl. 3, fig. 10; Dodge, 1985***: 93; Balech, 1988*: 143, pl. 61, fig. 4-6; Delgado & Fortuño, 1991***: fig. 6L; 5, pl. 8, fig. a, b, pl. 9, fig. d; Licea et al., 1995* **: pl. 1, fig. 3, pl. 17, fig. 5; Wiktor & Okolodkov, 1995*: 32, fig. 8a, b; Steidinger & Tangen, 1997*: 471, pl. 27; Konovalova, 1998*: 149, fig. 30(10, 11) (f. *arietinum* and f. *gracilentum* Jörg.); Hoppenrath et al., 2009** ***: 175, fig. 71m-p; Yongshui, 2009* **: 59, 64, fig. 66, 72 (including *C. bucephalum* var. *heterocamptum*), pl. 5, fig. 2.

26. *Ceratium symmetricum* Pavillard, 1905 (Pl. 5, Fig. 9; Pl. 12, Fig. 9)

Syn.: *Ceratium gracile* (Gourret) Jörg., 1911: 44, pl. 5, fig. 92-95.

Cell body with convex sides, sometimes slightly inflated on the left side, with notably convex posterior margin, lacking a notch between the antapical horns, slightly longer than wide. Apical horn rather short and slightly curved, positioned centrally. Antapical horns relatively long, continuously curved and directed anteriorly, positioned at about equal distance from the cell body. Widest point adjacent to the cingulum and the antapical horns. L 140-200 μm ($169.2 \pm 13.3 \mu\text{m}$), Wb 42.5-56 μm ($51.0 \pm 4.8 \mu\text{m}$), Wt 125-160 μm ($138.2 \pm 13.2 \mu\text{m}$); n=13.

Note: Two varieties of this species have been reported for the Gulf of Mexico (Steidinger et al., 2009).

Records in the State of Veracruz: Avendaño-Sánchez & Sotomayor-Navarro, 1982; Figueroa-Torres, 1990* ** (var. *coarctatum* (Pavillard) Graham et Bronikovsky); Zamudio-Resendiz, 1998. Extremely rare in NPSAV (Feb., March, May to Aug., Dec.).

References: Karsten, 1907*: pl. 48, fig. 7a, b (as *C. tripos coarctatum* Pavillard); Böhm, 1931a*: 358, fig. 11 (as *C. gracile*); Paulsen, 1931*: 82, fig. 49; Steemann

Nielsen, 1934*: 19, fig. 40, 41; Schiller, 1937*: 401, fig. 441a-d; Rampi, 1939*: 306, fig. 27; 1951*: 6, fig. 6 (a teratologic specimen); Graham & Bronikovsky, 1944*: 29, fig. 15H-L; López, 1966*: fig. 29, 30 (*C. symmetricum* and *C. symmetricum coarctatum*); Sournia, 1968*: 432, fig. 55-57 (three varieties are illustrated); Subrahmanyam, 1968*: 51, fig. 89-92; Wood, 1968*: 40, fig. 89; Steidinger & Williams, 1970**: 47, pl. 13, fig. 34 (var. *coarctatum*); Taylor, 1976*: 87, pl. 15, fig. 152-154, 156 (three varieties are illustrated); Trégouboff, 1978*: 115, pl. 26, fig. 3; Dowidar, 1983*: 14, pl. 4, fig. 5, pl. 6, fig. 1; Balech, 1988*: 143, pl. 61, fig. 7, 9; Delgado & Fortuño, 1991* ***: fig. 7A, G; 6, pl. 5, fig. a; Licea et al., 1995* ***: 47, pl. 5, fig. 1, 2, pl. 20, fig. 3; Steidinger & Tangen, 1997*: 478, pl. 28; Konovalova, 1998*: 150, fig. 30(1); Avancini et al., 2006* **: 299, fig. A-C; Yongshui, 2009* ** ***: 75, fig. 87, 88, pl. 7, fig. 1, 2, pl. 17, fig. 4 (var. *coarctatum* and var. *orthoceras*).

27a. *Ceratium declinatum* (G. Karst.) Jörg. var. *angusticornum* (Peters) F. J. R. Taylor, 1976 (Pl. 6, Fig. 1; Pl. 12, Fig. 10)

Syn.: *Ceratium declinatum* subsp. *angusticornum* Peters, 1934: 43, pl. 4, fig. 23b (invalid, see Sournia, 1973); *Ceratium declinatum* subsp. *angusticornum* (Peters) Graham et Bronikovsky, 1944: 32, fig. 17A-C (invalid, see Sournia, 1973).

This variety is distinguished from f. *normale* by the direction of the right antapical horn, the distal part of which forms an angle of about 90° with its proximal part, so that the distal parts of both antapical horns are slightly convergent. L 148-183 µm (161.6±13.7 µm), Wb 37.5-41.5 µm (39.1±1.7 µm), Wt 70-89 µm (82.0±7.4 µm); n=5.

A new record for the state of Veracruz. Extremely rare in NPSAV (Feb., March, Dec.).

Affinities: The species is morphologically similar to *C. arietinum*; however, the former has a subpentagonal cell body (the latter has a subtriangular cell body) and a more curved right antapical horn, especially in its distal part.

References: Taylor, 1976*: 83, pl. 16, fig. 164, 167; Yongshui, 2009*: 68, fig. 78.

27b. *Ceratium declinatum* (G. Karst.) Jörg., 1911 f. *normale* Jörg., 1911 (Pl. 6, Fig. 2; Pl. 13, Fig. 1)

Bas.: *Ceratium tripos declinatum* G. Karst., 1907: 406, pl. 48, fig. 2.

Cell body delicate, subtriangular, longer than it is wide. Posterior margin of the cell is generally convex, almost flat near the right antapical horn. Epitheca is

asymmetrically convex, much more on the right side than near the left one. Apical horn moderately long, slightly curved at its base and distally it is straight, strongly shifted to the left. Proximal parts of the antapical horns are directed laterally; distally they bend continuously and are directed anteriorly, being slightly divergent. Widest point adjacent to the cingulum or to the antapical horns. L 158-290 μm ($177.7 \pm 27.0 \mu\text{m}$), Wb 30-45 μm ($39.4 \pm 3.1 \mu\text{m}$), Wt 60-138 μm ($111.5 \pm 20.0 \mu\text{m}$); n=24.

Affinities: The taxon is very similar in shape to *C. tripos* var. *tripodoides*, but it is considerably smaller. The apical horn in *C. declinatum* is positioned markedly closer to the right side of the epitheca, whereas in *C. tripos* var. *tripodoides* it is centrally inserted. Also, it is similar to *C. arietinum*; however, *C. declinatum* has a more convex right side of the cell body.

Records in the State of Veracruz: Legaría-Moreno, 2003. Rare in NPSAV (Feb., March, May, June, Dec.).

References: Karsten, 1907*: pl. 48, fig. 2a, b; Jörgensen, 1911*: 42, fig. 87-89; 1920*: 66, fig. 63-65; Paulsen, 1931*: 83, fig. 50 (as *C. declinatum* Karsten var. *majus* Jörgensen); Steemann Nielsen, 1934*: 22, fig. 46, 47; Schiller, 1937*: 404, fig. 445; Rampi, 1939*: 307, fig. 26; 1951*: 6, fig. 6 (a teratologic specimen); Graham & Bronnikovsky, 1944*: 32, fig. 16Q-T, 17A-C; Kiselev, 1950*: 249, fig. 425; López, 1966*: fig. 32; Wood, 1954*: 293, fig. 218a-c; 1968*: 27, fig. 50; Sournia, 1968* **: 438, fig. 66, pl. 2, fig. 8 (six infraspecific taxa are distinguished); Steidinger et al., 1967***: pl. 6, fig. b (as *C. declinatum*); Subrahmanyam, 1968*: 54, fig. 98-101, pl. 4, fig. 20; Steidinger & Williams, 1970***: 45, pl. 7, fig. 18; Hermosilla, 1973*: 66, pl. 34, fig. 1-3; Taylor, 1976*: 82, pl. 16, fig. 163, 164, 166, 167; Pesantes-Santana, 1978*: 9, pl. 4, fig. 4, 5; Trégouboff, 1978*: 115, pl. 26, fig. 5; Licea et al., 1995***: 34, non fig. 3 (judging from the centrally positioned apical horn, most likely *C. tripos* var. *tripodoides* is illustrated); Steidinger & Tangen, 1997*: 472, pl. 26; Konovalova, 1998*: 149, fig. 30(9); Avancini et al., 2006* **: 285, fig. A-C.

28. *Ceratium carriense* Gourret, 1883 (Pl. 6, Fig. 3; Pl. 13, Fig. 2)

Cell body robust, subtrapezoidal. Posterior margin of the cell is flat and oblique, with a noticeable membrane near the left antapical horn. Epitheca is asymmetrically convex. Apical horn very long, straight or almost straight, centrally positioned. Antapical horns are very long. Proximal parts of the antapical horns are directed laterally-backward; distally they bend rather abruptly and are directed anteriorly-laterally or almost laterally, being strongly divergent. Widest point adjacent to the

antapical horns. L 420-770 μm ($613.4 \pm 116.4 \mu\text{m}$), Wb 62-75 μm ($69.7 \pm 3.5 \mu\text{m}$), Wt 890-1415 μm ($1129 \pm 150.6 \mu\text{m}$); n=20.

Records in the State of Veracruz: Figueroa-Torres, 1990* **. Rare in NPSAV (March, May, June).

References: Karsten, 1907*: pl. 49, fig. 17, 18 (as *C. tripos volans* var. *tenuissima* Kofoid and var. *elegans* Br. Schröder); Jörgensen, 1911*: 68, fig. 147a, b; 1920*: 89, fig. 81, 82; Pavillard, 1916*: 17, pl. 1, fig. 4 (*C. carriense* var. *volans*); Paulsen, 1931*: 90, fig. 57A-D; Steemann Nielsen, 1934*: 26, fig. 64; Schiller, 1937*: 425, fig. 464-466; Rampi, 1939*: 310, fig. 35, 37 (two forms are illustrated); Graham & Bronikovsky, 1944*: 39, fig. 22A; Wood, 1954*: 308, fig. 236a, b; 1968*: 25, fig. 46; Silva, 1956*: 66, pl. 9, fig. 5-8; Curl, 1959*: 306, fig. 122 (mistakenly identified as *C. trichoceros*, judging from the antapical horns); López, 1966*: fig. 47-49 (*C. carriense* and *C. carriense volans*); Subrahmanyam, 1968*: 77, fig. 143, 144, pl. 7, fig. 36; Steidinger & Williams, 1970**: 44, pl. 5, fig. 14a, b, 15a, b (*C. carriense* and *C. carriense* var. *volans*); Hassan, 1976*: 291, fig. 18a, b (var. *carriense*); Taylor, 1976*: 69, pl. 20, fig. 200; Pesantes-Santana, 1978*: 8, pl. 3, fig. 5; Trégouboff, 1978*: 116, pl. 26, fig. 16; Dodge, 1982*: 236, fig. 31G; Hernández-Becerril, 1988**: 189, l'am. 1, fig. 4; Licea et al., 1995**: 32, pl. 1, fig. 9; Steidinger & Tangen, 1997*: 471, pl. 29; Konovalova, 1998*: 156, fig. 31(6, 7) (var. *carriense* and var. *volans* (Cl.) Jörg).

29. *Ceratium macroceros* (Ehrenb.) Vanhöffen, 1897 var. *gallicum* (Kof.) Sournia, 1966 (Pl. 6, Fig. 4; Pl. 8, Fig. 4; Pl. 13, Fig. 3)

Bas.: *Peridinium macroceros* Ehrenb., 1840: 201.

Syn.: *Ceratium gallicum* Kofoid, 1907 (Univ. Calif. Publ. Zool. 3): 302, pl. 24, fig. 10-12.

Cell body rather delicate, subquadrangular, with nearly flat posterior margin. Apical horn very long, straight or almost straight, sometimes slightly curved in its proximal part. Proximal parts of the antapical horns are directed posteriorly, forming a deep notch between them; distally they bend rather abruptly and are directed anteriorly but generally diverge notably. Posterior membrane is well developed. Widest point adjacent to the antapical horns. L 260-470 μm ($392 \pm 70.5 \mu\text{m}$), Wb 47.5-55 μm ($50.4 \pm 2.9 \mu\text{m}$), Wt 220-400 μm ($329.9 \pm 45.7 \mu\text{m}$); n=21.

Note: Two varieties of this species have been reported for the Gulf of Mexico (Steidinger et al., 2009).

Records in the State of Veracruz: Ochoa-Figueroa, 1978; Avendaño-Sánchez & Sotomayor-Navarro, 1982; Figueroa-Torres, 1990*; Suchil-Vilchis, 1990;

Zamudio-Resendiz, 1998; Estradas-Romero, 2004. Common in NPSAV, probably, throughout the year.

References: Ostenfeld & Schmidt, 1901: 167, fig. 19; Karsten, 1907*: pl. 49, fig. 26-28; Paulsen, 1908*: 81, fig. 109; 1931*: 87, fig. 54A-C (as *C. macroceros* subsp. *gallicum* (Kofoid) Jörgensen); Jörgensen, 1911*: 63, fig. 132a, b, 133; 1920*: 83, fig. 77; Wailes, 1928*: 5, pl. 11, fig. 17, 18, non 16 (the specimens illustrated in fig. 17 and 18 are likely misidentifications, and they correspond well to *C. horridum*); Böhm, 1931b*: 38, fig. 35a; Steemann Nielsen, 1934*: 25, fig. 59; Schiller, 1937*: 428, fig. 468; Rampi, 1939*: 310, fig. 42; Graham & Bronikovsky, 1944*: 37, fig. 21B-F; Kiselev, 1950*: 254, fig. 422; Kato, 1957*: 18, pl. 7, fig. 23; Margalef, 1961a*: 81, pl. 7 (as *C. massiliense* var. *gallicum* (Kof.) Jörg.); López, 1966*: fig. 16; Sournia, 1968*: 460, fig. 83-85 (var. *macroceros* and var. *gallicum*); Subrahmanyam, 1968*: 79, fig. 149, 150, pl. 4, fig. 24, pl. 5, fig. 25, 26, pl. 6, fig. 29, 30; Wood, 1968*: 30, fig. 59 (as *Ceratium gallicum* Kofoid); 36, fig. 77; Steidinger & Williams, 1970**: 46, pl. 11, fig. 29a, b; Drebes, 1974**: 149, fig. 132; Taylor, 1976*: 72, pl. 20, fig. 198, 199, pl. 22, fig. 218; Pesantes-Santana, 1978*: 15, pl. 11, fig. 3; Trégouboff, 1978*: 116, pl. 26, fig. 17; Tester & Steidinger, 1979**: 29, pl. 11, fig. 68; Dodge, 1982*: 235, fig. 31A; Dowidar, 1983*: 17, pl. 7, fig. 5; Balech, 1988*: 146, pl. 64, fig. 1, 4; Konovalova et al., 1989* **: 135, pl. 23, fig. 3; Licea et al., 1995**: 42, pl. 4, fig. 1, 2; 2004**: fig. 14; Wiktor & Okolodkov, 1995*: 42, fig. 13a, b; Konovalova, 1998* **: 153, fig. 32(4, 5) (var. *macroceros* and var. *gallicum* (Kof.) Jörg.); Alonso-Rodríguez et al., 2008**: 129; Hoppenrath et al., 2009**: 178, fig. 72i, j; Yongshui, 2009*: 41, fig. 47.

30. ***Ceratium horridum* (Cleve) Gran, 1902** (Pl. 6, Fig. 5-7; Pl. 13, Fig. 4 and 5)

Bas.: *Ceratium tripos* var. *horridum* Cleve, 1897: 302, fig. 2.

Syn.: *Ceratium tenue* (Ostenf. et J. Schmidt) Jörg., 1911 (Intern. Rev. d. ges. Hydrob. u. Hydrog. 4, Suppl.-Heft, 1): 77, fig. 163; *C. intermedium* (Jörg.) Jörg., 1911 (Intern. Rev. d. ges. Hydrob. u. Hydrog. 4, Suppl.-Heft, 1): 83, fig. 174-176; *C. claviger* Kof., 1907 (Bull. Mus. Comp. Zool. Harv. Coll. 50, 6): 170, pl. 4, fig. 27.

Cell body relatively robust. Posterior margin of the cell oblique. Apical horn rather long, almost straight, positioned centrally. Proximal parts of the antapical horns are directed laterally, lacking a notch between them; distally they bend continuously and are directed anteriorly, being slightly parallel to each other. Widest point adjacent to the antapical horns.

Note: Three varieties have been reported for the Gulf of Mexico (Steidinger et al., 2009). The taxonomy of the species is extremely complicated. Numerous in-

fraspecific taxa of *C. horridum* are known. Furthermore, there is no agreement as to whether *C. tenue* is synonymous to *C. horridum* or a different species.

Records in the State of Veracruz: Avendaño-Sánchez & Sotomayor-Navarro, 1982; Figueroa-Torres, 1990* **; Estradas-Romero, 2004. Rare to common in NPS-AV (March, Oct., Dec.).

References: Ostenfeld, 1903*: 584, fig. 136-139; Karsten, 1907*: pl. 48, fig. 16 (as *C. tripos buceros* O. Zacharias), pl. 49, fig. 19-21 (as *C. tripos inclinatum* Kofoed and *C. tripos inclinatum* var. *aequatorialis* Br. Schröder); Pavillard, 1916*: 18, pl. 1, fig. 5, 6; Jörgensen, 1920*: 96, fig. 86-92; Lebour, 1925*: 155, pl. 34, fig. 2; Wailes, 1928*: 5, pl. 1, fig. 1; Böhm, 1931a*: 365, fig. 20 (as *C. horridum* var. *tenue*); 1931b*: 41, fig. 36a-g; Schiller, 1937*: 413, fig. 455a-c, 456; Graham & Bronnikovsky, 1944*: 42, fig. 23I-L; Kiselev, 1950*: 253, fig. 430; Wood, 1954*: 300, fig. 230a, b, 231a-i; 1968*: 32, fig. 65; Kato, 1957*: 17, pl. 5, fig. 14; Curl, 1959*: 306, fig. 118 (the specimen given as *C. macroceros* is likely a misidentification, and the figure satisfactorily corresponds to *C. horridum*); López, 1966*: fig. 42, 43; Sournia, 1968* **: 474, fig. 91-95 pl. 3, fig. 12 (three infraspecific taxa are distinguished); Subrahmanyam, 1968*: 63, fig. 113-128; Drebes, 1974**: 145, fig. 129a; Hassan, 1976*: 291, fig. 14 (*C. horridum* var. *molle*); Taylor, 1976*: 71, pl. 20, fig. 202, pl. 21, fig. 203-208, 211, 212; Pesantes-Santana, 1978*: 13, pl. 11, fig. 4; Burns & Mitchell, 1982***: 60, fig. 11; Dowidar, 1983*: 19, pl. 6, fig. 6, pl. 7, fig. 2; Balech, 1988*: 148, pl. 65, fig. 3-9; Delgado & Fortuño, 1991***: 6, pl. 1, fig. c, d; Wiktor & Okolodkov, 1995*: 38, fig. 11a, b; Licea et al., 1995* **: 39, pl. 3, fig. 3a, b, 4, pl. 18, fig. 11; Steidinger & Tangen, 1997*: 474, pl. 28; Konovalova, 1998*: 158, fig. 31(2-4) (three infraspecific taxa are illustrated); Bérard-Therriault et al., 1999**: 164, pl. 83d; Hoppenrath et al., 2009**: 178, fig. 72a-g; Yongshui, 2009**: pl. 3, fig. 1-4.

var. *buceros* (Zacharias) Sournia, 1966 (Pl. 6, Fig. 5; Pl. 13, Fig. 5)

Cells with slender, usually delicate and thin, markedly divergent antapical horns. Antapical horns are much shorter than the apical one ($3/5$ - $2/3$ of the apical horn length). The posterior margin of the cell is not dentate. L 160-270 μm (211.9 ± 30.1 μm), Wb 34-40 μm (37.8 ± 1.8 μm), 130-240 μm (158.6 ± 24.8 μm); n=21.

Records in the State of Veracruz: Figueroa-Torres, 1990* ** (as *C. buceros* var. *tenue*).

References: Karsten, 1907*: pl. 48, fig. 16 (as *C. tripos buceros* O. Zacharias); Rampi, 1942*: 226, fig. 9; Steidinger & Williams, 1970**: 44, pl. 4, fig. 12 (as *C.*

buceros f. *tenue*); Trégouboff, 1978*: 116, pl. 26, fig. 20 (as *C. buceros* f. *tenue* (Ost. et Schm.) Schill.).

var. *molle* (Kof.) Jörg., 1911 (Pl. 6, Fig. 6 and 7; Pl. 13, Fig. 4)

Cell with coarse parallel, slightly divergent or slightly convergent antapical horns. All horns are subequal in length (at least in our samples). The posterior margin of the cell is often markedly dentate.

L 157-470 μm ($241.9 \pm 67.9 \mu\text{m}$), Wb 30-48 μm ($43.2 \pm 3.6 \mu\text{m}$), Wt 120-200 μm ($163.7 \pm 18.4 \mu\text{m}$); n=24.

References: Jörgensen, 1920*: 96, fig. 87; Rampi, 1942*: 226, fig. 17; Graham & Bronikovsky, 1944*: 42, fig. 23I, K, 25D; Hassan, 1976*: 291, fig. 14; Taylor, 1976*: 71, pl. 21, fig. 208; Balech, 1988*: 149, pl. 65, fig. 8, 9; Konovalova, 1998*: 158, fig. 31, fig. 4; Yongshui, 2009**: pl. 3, fig. 2.

31. *Ceratium massiliense* (Gourret) Jörg., 1911 var. *armatum* (G. Karst.) Jörg., 1911 (Pl. 6, Fig. 8; Pl. 7, Fig. 2; Pl. 8, Fig. 5; Pl. 9, Fig. 9; Pl. 13, Fig. 6)

Bas.: *Ceratium tripos* var. *massiliense* Gourret, 1883: 27, pl. 1, fig. 2.

Cell body robust, subtriangular, with nearly flat posterior margin. Apical horn very long, straight. The proximal part of the left antapical horn is directed posteriorly and that of the right horn laterally-posteriorly. A notch between the antapical horns is notable only near the right horn. Posterior membrane is well developed. Widest point adjacent to the antapical horns. L 285-650 μm ($464.8 \pm 105.4 \mu\text{m}$), Wb 67.5-78 μm ($71.6 \pm 3.3 \mu\text{m}$), Wt 280-540 μm ($411.9 \pm 76.1 \mu\text{m}$); n=21. Chains of 2 cells were observed.

Note: This species has repeatedly been reported for the Gulf of Mexico although without distinguishing infraspecific forms (Steidinger et al., 2009). A teratologic specimen, with the left antapical horn twisted and directed backward, was observed (Pl. 7, Fig. 2). It corresponds well to *C. recurvatum* Schröder figured by Taylor (1976: 74, pl. 21, fig. 209) who commented that “perhaps this taxon is a conglomerate of several species exhibiting a particular type of horn aberration”. Also, it is similar to *C. recurvatum* in Yongshui (2009: 47, fig. 55, pl. 3, fig. 6) and to *C. deflexum* (Kof.) Jörg. in Schiller (1937: 428, fig. 467b).

Records in the State of Veracruz: Ochoa-Figueroa, 1978; Avendaño-Sánchez & Sotomayor-Navarro, 1982; Figueroa-Torres, 1990* **. Common in NPSAV throughout the year.

References: Jörgensen, 1911*: 66, fig. 140-142; 1920*: 85, fig. 78-80; Böhm, 1931a*: 362, fig. 16 (*C. massiliense* f. *protuberans* (Karsten), *C. massiliense* f. *ellipticum* n. f. and *C. massiliense* α -*macroceroides*); 1931b*: 35, fig. 32a-d; Paulsen, 1931*: 89, fig. 55A-F; Steemann Nielsen, 1934*: 25, fig. 60-62; Schiller, 1937*: 422, fig. 463a-d; Rampi, 1939*: 308, fig. 32, 33, 40 (*C. massiliense* (Gourret) Jörg. f. *armatum* (Karsten) Jörg., f. *macroceroides* (Karsten) Jörg. and f. *protuberans* (Karsten) Jörg.); Graham & Bronikovsky, 1944*: 38, fig. 22E-L; Wood, 1954*: 306, fig. 235a-c; 1968*: 36, fig. 78; Kato, 1957*: pl. 6, fig. 18, 20 (*C. massiliense* and *C. massiliense* var. *protuberans* (Karsten) Jörgensen); Curl, 1959*: 306, fig. 119; Margalef, 1961a*: 81, fig. 26h, pl. 6, 7, 10; López, 1966*: fig. 51; Sournia, 1968*: 465, fig. 87, 88 (three infraspecific taxa are distinguished); Subrahmanyam, 1968*: 74, pl. 4, fig. 23, pl. 7, fig. 34, 35; Steidinger & Williams, 1970**: 46, pl. 11, fig. 30a, b, pl. 12, fig. 30c-e; Hermosilla, 1973*: 64, pl. 33, fig. 3, 4; Hassan, 1976*: 290, fig. 9-11 (var. *massiliense* and var. *protuberans*); Taylor, 1976*: 73, pl. 20, fig. 193-196; Pesantes-Santana, 1978*: 15, pl. 3, fig. 1, 2; Trégouboff, 1978*: 116, pl. 26, fig. 15; Tester & Steidinger, 1979**: 29, pl. 11, fig. 69; Burns & Mitchell, 1982***: 62, fig. 11-13 (the specimen illustrated in fig. 11 corresponds rather well to *C. contrarium*; see Sournia, 1968; Balech, 1988); Dowidar, 1983*: 18, pl. 2, fig. 11, pl. 8, fig. 1; Balech, 1988*: 147, pl. 64, fig. 6; Delgado & Fortuño, 1991***: 6, pl. 9, fig. a, c, pl. 10, fig. a; Licea et al., 1995* **: pl. 4, fig. 3 (f. *armatum*), pl. 19, fig. 6 (var. *massiliense*); 2004***: fig. 10; Steidinger & Tangen, 1997*: 477, pl. 33; Konovalova, 1998*: 154, fig. 33(1, 2) (var. *massiliense* and var. *armatum*); Alonso-Rodríguez et al., 2008***: 130; Yongshui, 2009* ** ***: 45, fig. 52, pl. 3, fig. 5, pl. 13, fig. 1.

32. *Ceratium contrarium* (Gourret) Pavillard, 1905 (Pl. 6, Fig. 9; Pl. 13, Fig. 7)

Bas.: *Ceratium tripos* var. *contrarium* Gourret, 1883: pl. 3, fig. 51.

Syn.: *Ceratium trichoceros* (Ehrenb.) Kof. var. *contrarium* (Gourret) J. Schill., 1937: 431, fig. 471.

Cell body rather delicate, subtrapezoidal, with nearly flat, notably oblique posterior margin. Apical horn very long, straight. Proximal parts of the antapical horns are directed laterally-posteriorly, forming a shallow notch between them; distally they bend continuously and are directed anteriorly, being in general slightly divergent or parallel to each other. Antapical horns are often undulating. Posterior membrane is poorly developed. Widest point adjacent to the antapical horns. L 353-640 μm ($443.1 \pm 89.7 \mu\text{m}$), Wb 50-65 μm ($56.8 \pm 4.2 \mu\text{m}$), Wt 297-420 μm ($354.4 \pm 35.8 \mu\text{m}$); n=25.

Affinities: *C. trichoceros*. In comparison, *C. contrarium* has a larger cell body and a shallower notch between the proximal parts of the antapical horns. Furthermore, the epitheca is usually slightly lower.

Records in the State of Veracruz: Zamudio-Resendiz, 1998 (as *C. cf. contrarium*); Estradas-Romero, 2004. Rare to common in NPSAV, throughout the year.

References: Graham & Bronikovsky, 1944*: 40, fig. 22E, 24A, B; López, 1966*: fig. 46; Sournia, 1968*: 473, fig. 90; Subrahmanyam, 1968*: 82, fig. 148; Wood, 1968*: 26, fig. 49; Hassan, 1976*: 290, fig. 13; Taylor, 1976*: 69, pl. 21, fig. 213; Trégouboff, 1978*: 116, pl. 26, fig. 18; Burns & Mitchell, 1982***: 62, non fig. 15 (as indicated on p. 62); Licea et al., 1995*: 33, pl. 17, fig. 12; Konovalova, 1998*: 162, fig. 33(8); Yongshui, 2009*: pl. 2, fig. 11.

33. *Ceratium trichoceros* (Ehrenb.) Kof., 1908 (Pl. 7, Fig. 1; Pl. 13, Fig. 8)

Bas.: *Peridinium trichoceros* Ehrenb., 1859: 791; 1873: 3, pl. 1(1).

Cell body very delicate, subtrapezoidal, with nearly flat, notably oblique posterior margin. Apical horn very long, straight. Proximal parts of the antapical horns are directed laterally-posteriorly, forming a shallow notch between them; distally they bend continuously and are directed anteriorly, being in general slightly divergent or parallel to each other. Antapical horns are often undulating. Posterior membrane is poorly developed. Widest point adjacent to the antapical horns. L 182-380 μm ($318.8 \pm 48.0 \mu\text{m}$), Wb 30-45 μm ($39.3 \pm 3.1 \mu\text{m}$), Wt 230-340 μm ($286.7 \pm 29.7 \mu\text{m}$); n=23.

Affinities: *C. contrarium*. In comparison, *C. trichoceros* has a smaller cell body and a deeper notch between the proximal parts of the antapical horns. Additionally, the epitheca is usually slightly higher.

Records in the State of Veracruz: Figueroa-Torres, 1990* **; Zamudio-Resendiz, 1998; Aquino-Cruz, 2002* **; Tejeda-Hernández, 2005**. Very common in NPSAV, probably, throughout the year.

References: Jörgensen, 1911*: 75, fig. 159a, b; 1920*: 95, fig. 85; Steemann Nielsen, 1934*: 27, fig. 68; Schiller, 1937*: 430, fig. 470; Rampi, 1939*: 310, fig. 39; Graham & Bronikovsky, 1944*: 40, fig. 22B; Kato, 1957*: 19, pl. 6, fig. 19a, b; Margalef, 1961a*: 81, fig. 26i, pl. 6, 8, 10; López, 1966*: fig. 44, 45; Sournia, 1968*: 472, fig. 89; Steidinger et al., 1967**: pl. 6, fig. c; Subrahmanyam, 1968*: 81, fig. 147, pl. 7, fig. 37; Wood, 1968*: 40, fig. 91; Steidinger & Williams, 1970**: 47, pl. 14, fig. 36a-c; Hassan, 1976*: 290, fig. 12; Taylor, 1976*: 75, pl. 12, fig. 117, pl. 21, fig. 210; Pesantes-Santana, 1978*: 18, pl. 13, fig. 1, 2; Tester & Steidinger, 1979**: 29, pl. 12, fig. 72; Burns & Mitchell, 1982***: fig. 16; Dowidar, 1983*: 18, pl. 4, fig. 2; Balech,

1988*: 150, pl. 66, fig. 4; Licea et al., 1995**: 47, pl. 5, fig. 4; 2004**: fig. 4; Steidinger & Tangen, 1997*: 478, pl. 29; Konovalova, 1998***: 162, pl. 14(1-4); Avancini et al., 2006* **: 301, fig. A, B; Alonso-Rodríguez et al., 2008**: 131; Yongshui, 2009* ** ***: 48, fig. 56, pl. 3, fig. 7, pl. 13, fig. 2.

DISCUSSION

The total absence of any species of the subgenus *Archaeoceratium* Jörgensen (*Ceratium cephalotum* (Lemmerm.) Jörg., *C. praelongum* (Lemmerm.) Kof. and *C. gravidum* Gourret) in the present samples can be explained by their preference for oceanic waters. Furthermore, they are umbriphilic (shade-loving, or shade species), preferring depths below 50-100 m (Steemann Nielsen, 1934, Graham & Bronikowsky, 1944; Taylor, 1976). Steidinger et al. (2009) report these species from the Gulf of Mexico. The first two species have been reported from offshore waters of the State of Veracruz (Figueroa-Torres, 1990).

Only a small amount of information about the species composition of *Ceratium* in Veracruz waters exists in a dozen BSc and MSc theses and one article in a periodical of very limited distribution. Three of the theses include very schematic line drawings or photographs of several species (Suchil-Vilchis, 1990; Aquino-Cruz, 2002; Tejeda-Hernández, 2005). Work on a *Ceratium furca* var. *hircus* bloom includes photos of this species (Guerra-Martínez & Lara-Villa, 1996). Thus, a robust critical review of existing records of the species of *Ceratium* in Veracruz water is impossible. Moreover, there are species never observed in our samples that have been reported by other authors from Veracruz-southern Tamaulipas waters: *C. concilians* Jörg., *C. deflexum* (Kof.) Jörg., *C. lineatum* (Ehrenb.) Cleve, *C. longinum* G. Karst., *C. longipes* (Bailey) Gran, *C. minutum* Jörg. and *C. paradoxides* Cleve (Avendaño-Sánchez & Sotomayor-Navarro, 1982; Figueroa-Torres, 1990; Suchil-Vilchis, 1990; Zamudio-Resendiz, 1998; Aquino-Cruz, 2002; Estradas-Romero, 2004). *C. concilians* can be easily confused with *C. gibberum* (e.g., see Böhm, 1931a: 379, fig. 36A-F), although Balech (1988) distinguishes them by a number of features. *C. deflexum* is morphologically similar to *C. macroceros*, and therefore some authors have probably confused them, according to Pavillard (1931) and Sournia (1968); others considered it a subspecies of *C. macroceros* (Jörgensen, 1911) or a form of *C. massiliense* (Peters, 1934). Identifications of *C. lineatum* and *C. minutum* are likely to be misidentifications, at least in some cases: confusion between them and *C. kofoidii*, *C. teres* and even with specimens of *C. pentagonum* with a short apical horn

(all three species are very common in the NPSAV) are quite possible. *C. lineatum* is widely distributed, and it has an Antarctic-tropical-boreal range (Okolodkov, 1996). *C. longinum* is mentioned in the present paper as a synonym to *C. contortum*, in accordance with Graham & Bronikovsky (1944) and Taylor (1976). Wood (1968) treats it separately and also indicates the similarity between *C. longinum* and *C. karstenii*. As for *C. longipes*, it is a cold-water species and may be confused with *C. horridum* (Wood, 1968; Steidinger & Tangen, 1997; Konovalova, 1998), which is rather common in the tropical zone, making a misidentification possible. Its distribution seems to be limited by the temperate (boreal) zone in the Northern Hemisphere; it is characteristically absent in the classic monographs by Sournia (1968), Taylor (1976) and Balech (1976, 1988), and in the checklist of dinoflagellates of the Mexican Pacific (Okolodkov & Gárate-Lizárraga, 2006). *C. paradoxides* is a rare umbriphilic oceanic species (Balech, 1988) morphologically similar to *C. limulus*.

New records (*Ceratium dens*, *C. bigelowii*, *C. limulus*, *C. tripos* f. *tripodoides* and *C. declinatum* var. *angusticornum*) for the Mexican part of the Gulf of Mexico were mainly from an oceanographic station situated further from the coastline. In some samples *C. dens* was rather frequent. Although a recent extension of its original geographic range in the Pacific Ocean might occur (Gárate-Lizárraga, 2009), it is hard to say if it is true for the Gulf of Mexico. Because the so-called grey literature (in particular, theses) was considered in the present study, the percentage of new records is relatively low. On the other hand, the data presented here are generally in agreement with those taken from the revised theses.

One of the varieties of *Ceratium tripos*, var. *pulchellum* (Schröder) López ex Sournia (= *C. pulchellum* Schröder), reported by Figueroa-Torres (1990) and Zamudio-Resendiz (1998) was not observed in the samples from the NPSAV. This species was one of the most abundant, and it was difficult to distinguish between var. *tripos* and var. *breve*. The specimens of *C. tripos* var. *tripodoides*, easily distinguishable from others, were usually rare and occasionally were more frequent than the other two.

On the whole, the species composition of *Ceratium* in the NPSAV is very similar to that in any well-studied tropical or subtropical region (Sournia, 1968; Subrahmanyam, 1968; Wood, 1968; Steidinger & Williams, 1970; Taylor, 1976) and in particular to that previously reported (Figueroa-Torres, 1990) in Veracruz waters. It consists of about 67% of the number of *Ceratium* species reported by Licea et al. (2004) for the southern Gulf of Mexico (based on 11 oceanographic cruises and 608 sampling sites between 1979 and 2002) and approximately 47% of the total number of *Ceratium* species known for the entire Gulf of Mexico (Steidinger et al., 2009).

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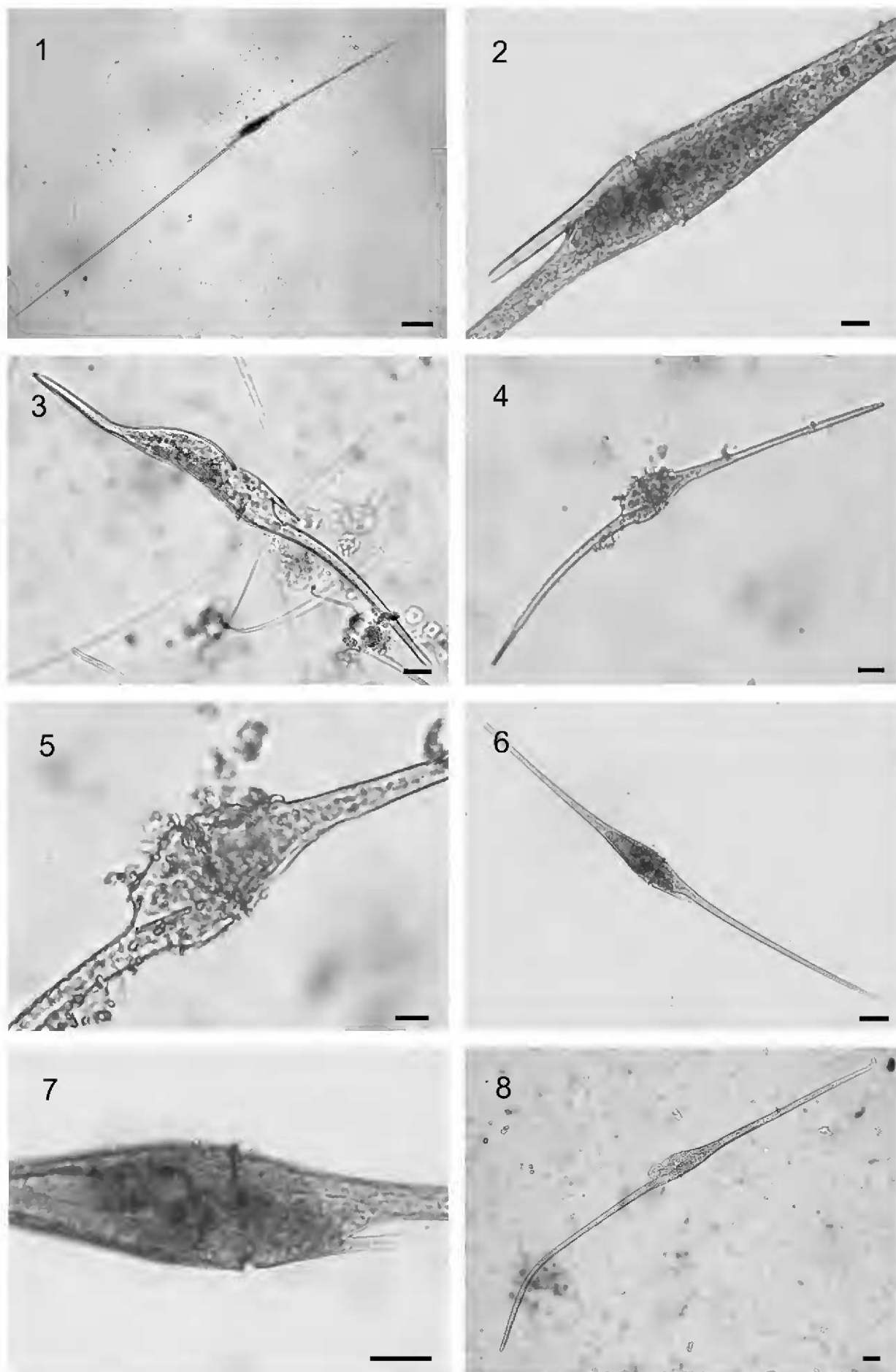


Plate 1. Fig. 1 and 2. *Ceratium extensum* in ventral view (VV). Fig. 3. *C. geniculatum* in dorsal view (DV). Fig. 4 and 5. *C. bigelowii* (VV). Fig. 6 and 7. *C. fusus* (VV). Fig. 8. *C. inflatum* (VV). Scale bars: 100 µm in Fig. 1; 10 µm in Fig. 2, 5 and 7; 20 µm in Fig. 3, 4, 6 and 8.

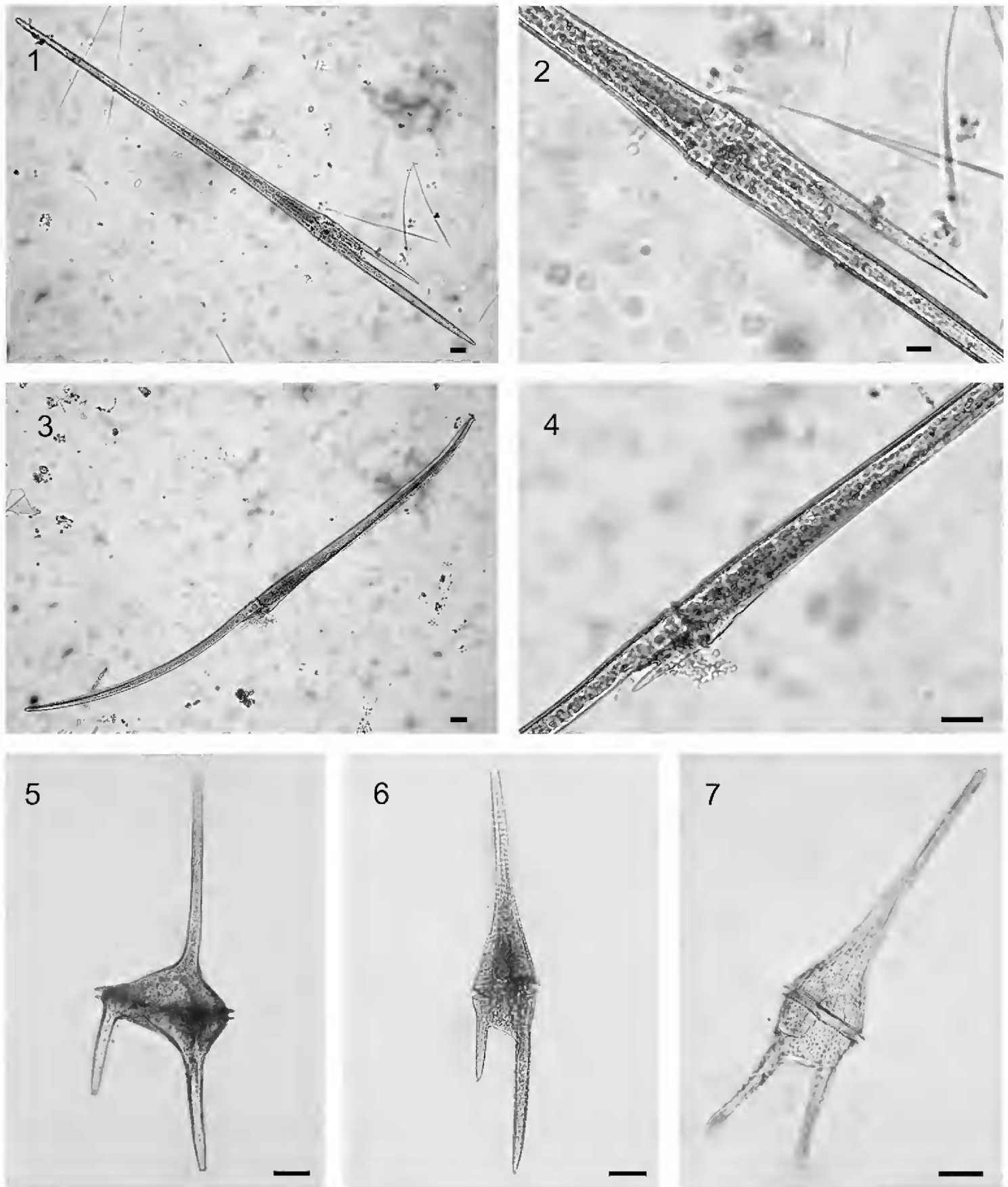


Plate 2. Fig. 1 and 2. *Ceratium belone* (DV). Fig. 3 and 4. *C. longirostrum* (DV). Fig. 5. *C. candelabrum* (VV). Fig. 6. *C. furca* var. *furca* (VV). Fig. 7. *C. furca* var. *hircus* (DV). Scale bars: 20 μ m in Fig. 1 and 3-7; 10 μ m in Fig. 2.

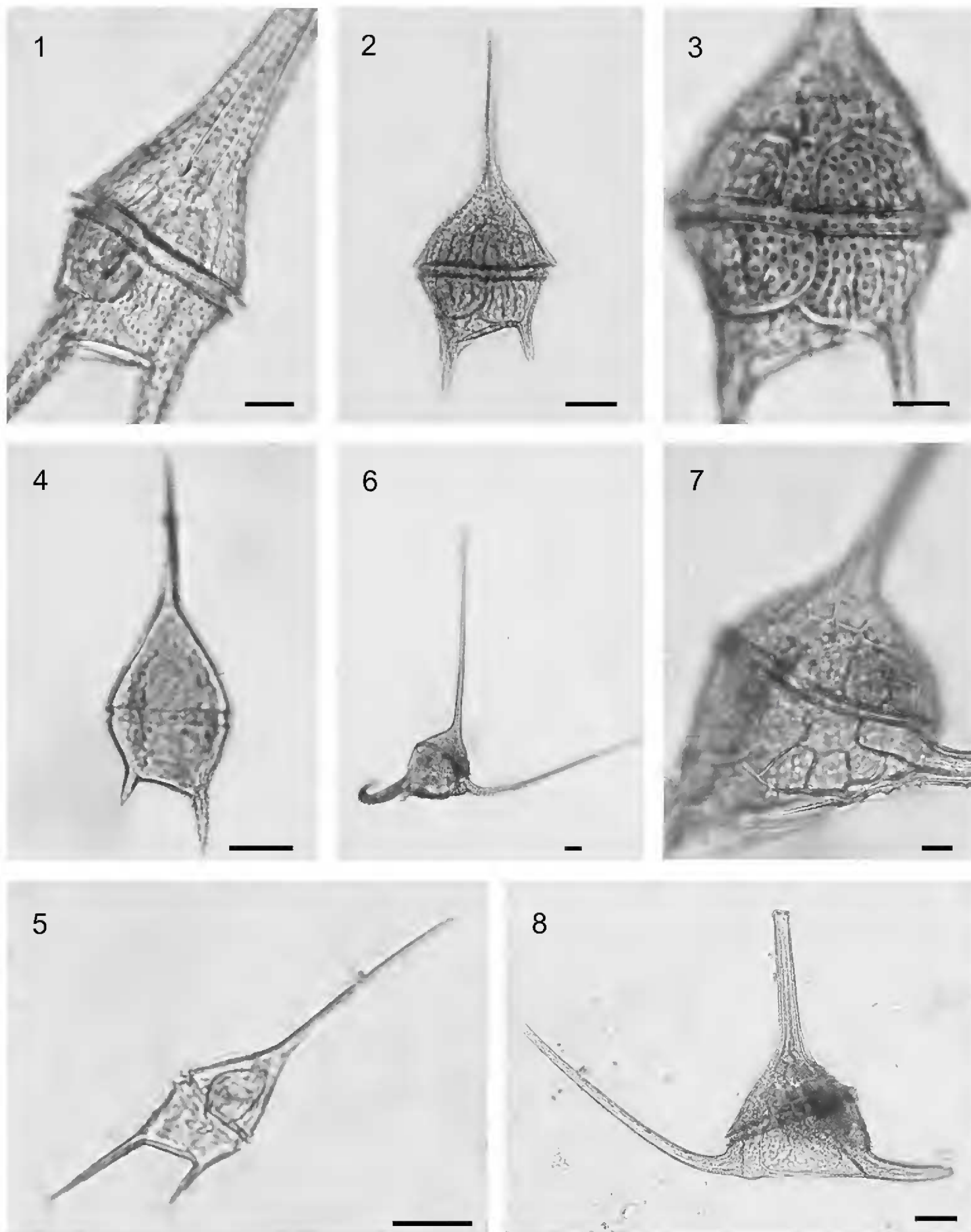


Plate 3. Fig. 1. *Ceratium furca* var. *hircus* (DV). Fig. 2 and 3. *C. pentagonum* var. *tenerum* (DV). Fig. 4. *C. teres* (VV). Fig. 5. *C. kofoidii* (DV). Fig. 6 and 7. *C. hexacanthum* (DV). Fig. 8. *C. dens* (VV). Scale bars: 10 μm in Fig. 1, 3 and 7; 20 μm in Fig. 2, 4-6 and 8.

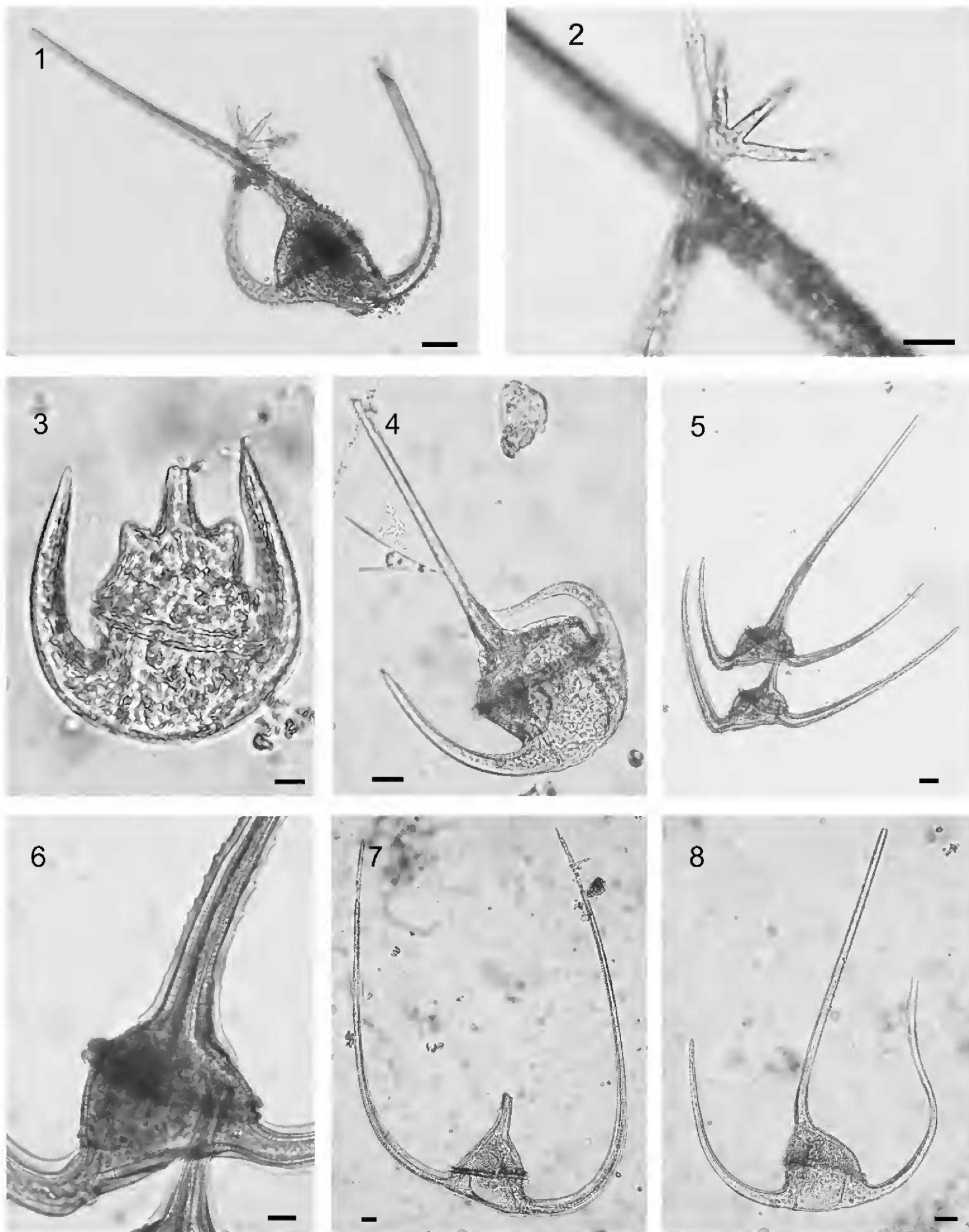


Plate 4. Fig. 1 and 2. *Ceratium ranipes* (VV). Fig. 3. *C. limulus* (DV). Fig. 4. *C. gibberum* var. *dispar* (DV). Fig. 5 and 6. *C. vultur* f. *vultur*, two cells (DV). Fig. 7. *C. lunula* (VV). Fig. 8. *C. contortum* var. *contortum* (DV). Scale bars: 20 μm in Fig. 1, 4, 5, 7 and 8; 10 μm in Fig. 2, 3, 6.

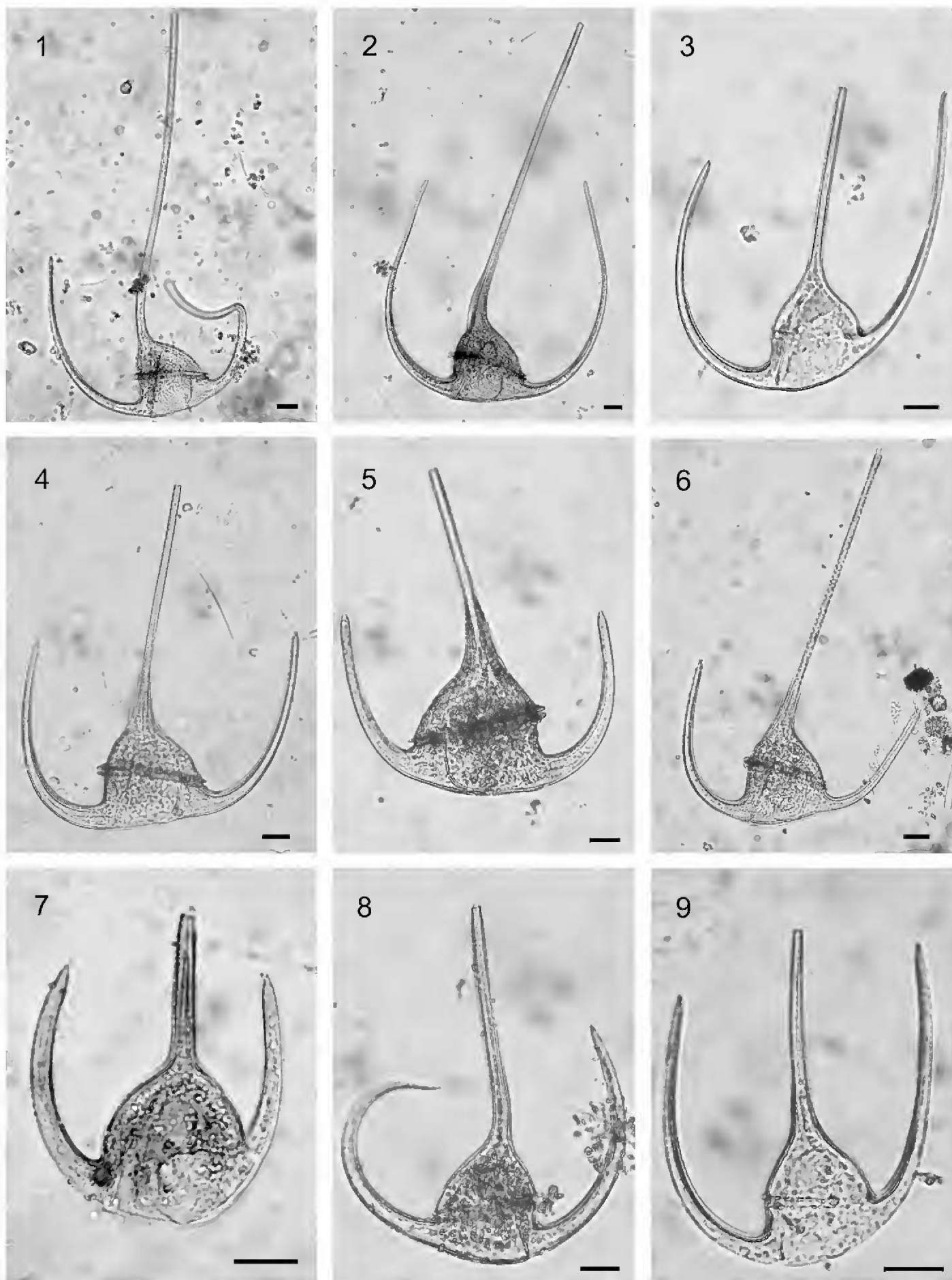


Plate 5. Fig. 1. *Ceratium contortum* var. *saltans* (DV). Fig. 2. *C. karstenii* (DV). Fig. 3. *C. euarcuratum* (DV). Fig. 4. *C. tripos* var. *tripos* (DV). Fig. 5. *C. tripos* var. *breve* (VV). Fig. 6. *C. tripos* f. *tripodoides* (DV). Fig. 7. *C. azoricum* (DV). Fig. 8. *C. arietinum* var. *gracilentum* (VV). Fig. 9. *C. symmetricum* (DV). Scale bars: 20 μ m.

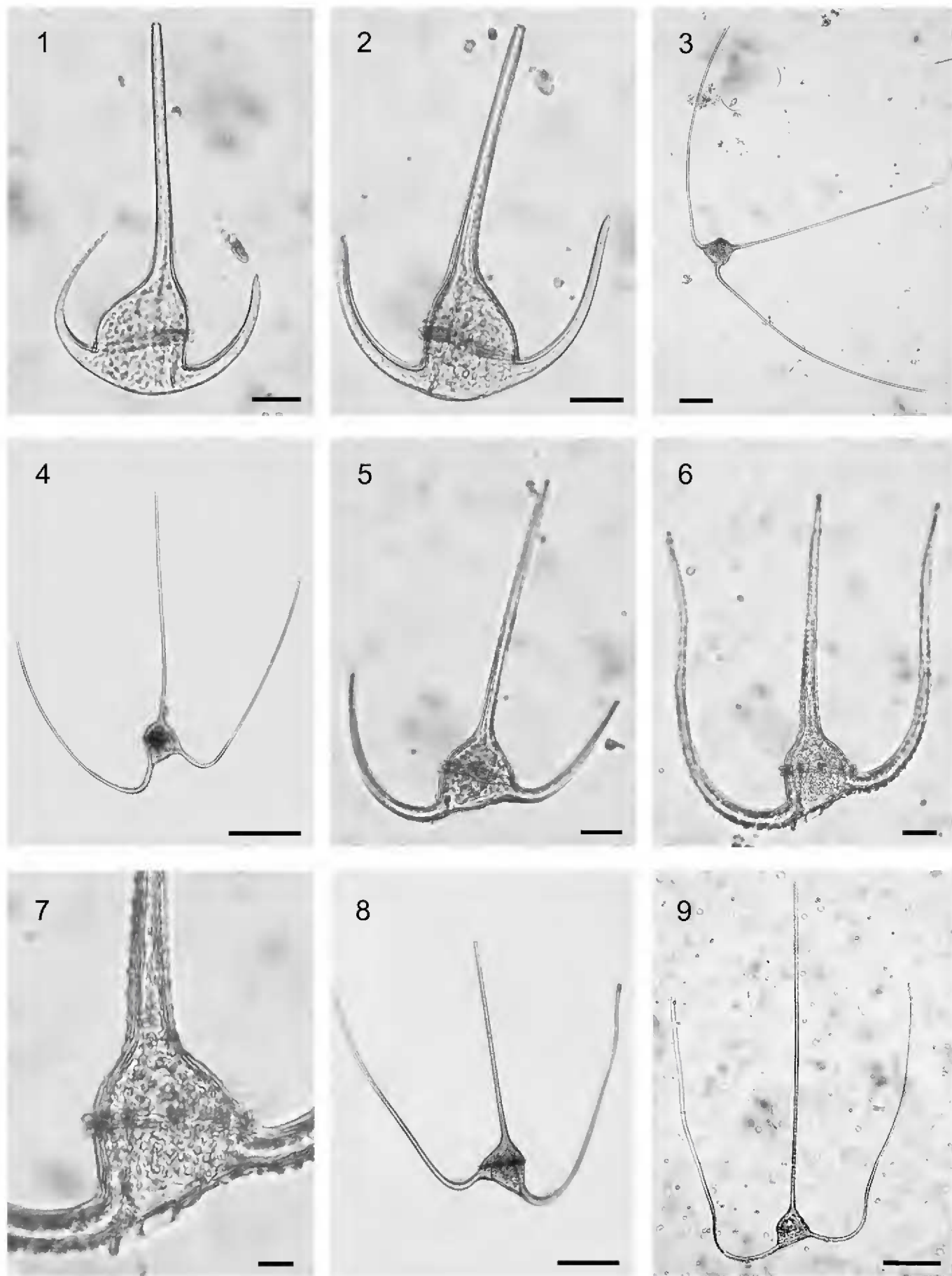


Plate 6. Fig. 1. *Ceratium declinatum* var. *angusticornum* (VV). Fig. 2. *C. declinatum* f. *normale* (DV). Fig. 3. *C. carriense* (DV). Fig. 4. *C. macroceros* var. *gallicum* (DV). Fig. 5. *C. horridum* var. *buceros* (DV). Fig. 6 and 7. *C. horridum* var. *molle* (DV). Fig. 8. *C. massiliense* var. *armatum* (VV). Fig. 9. *C. contrarium* (DV). Scale bars: 20 μm in Fig. 1, 2, 5 and 6; 100 μm in Fig. 3, 4, 8 and 9; 10 μm in Fig. 7.



Plate 7. Fig. 1. *Ceratium trichoceros* (VV). Fig. 2. *C. massiliense* var. *armatum*, a teratologic cell (DV). Fig. 3. A microgamete, presumably belonging to *C. tripos* (DV). Scale bars: 20 μm in Fig. 1 and 2; 10 μm in Fig. 3.

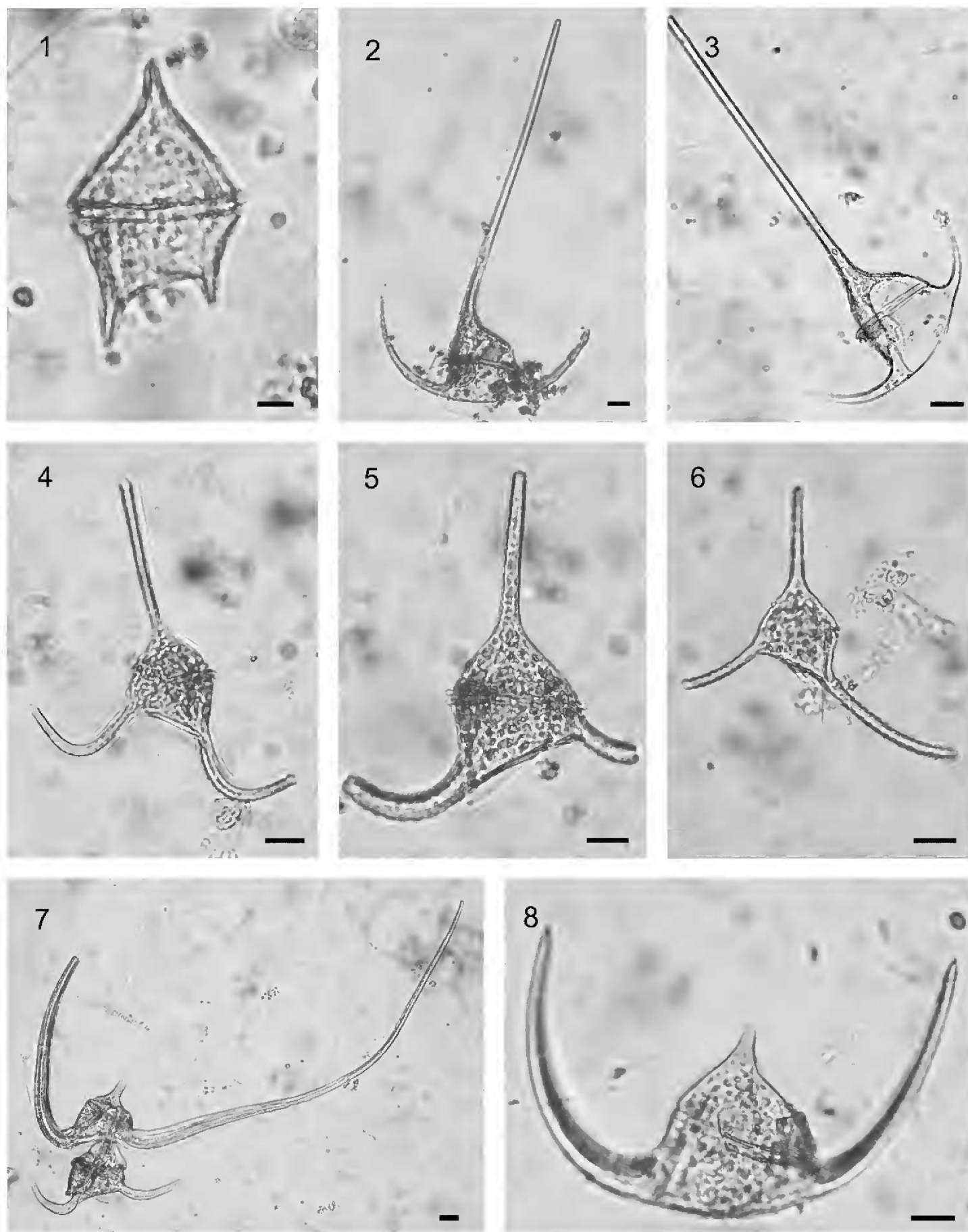


Plate 8. Recently divided cells of *Ceratium* species. Fig. 1. *C. pentagonum* var. *tenerum* (DV). Fig. 2. *C. contortum* (DV). Fig. 3. *C. tripos* f. *tripodoides* (DV). Fig. 4. *C. macroceros* var. *gallicum* (VV). Fig. 5. *C. massiliense* var. *armatum* (DV). Fig. 6. *C. contortum* (VV). Fig. 7. *C. vultur* f. *vultur*, two cells (DV). Fig. 8. *C. tripos* var. *tripos* (DV). Scale bars: 10 µm in Fig. 1; 20 µm in Fig. 2-8.

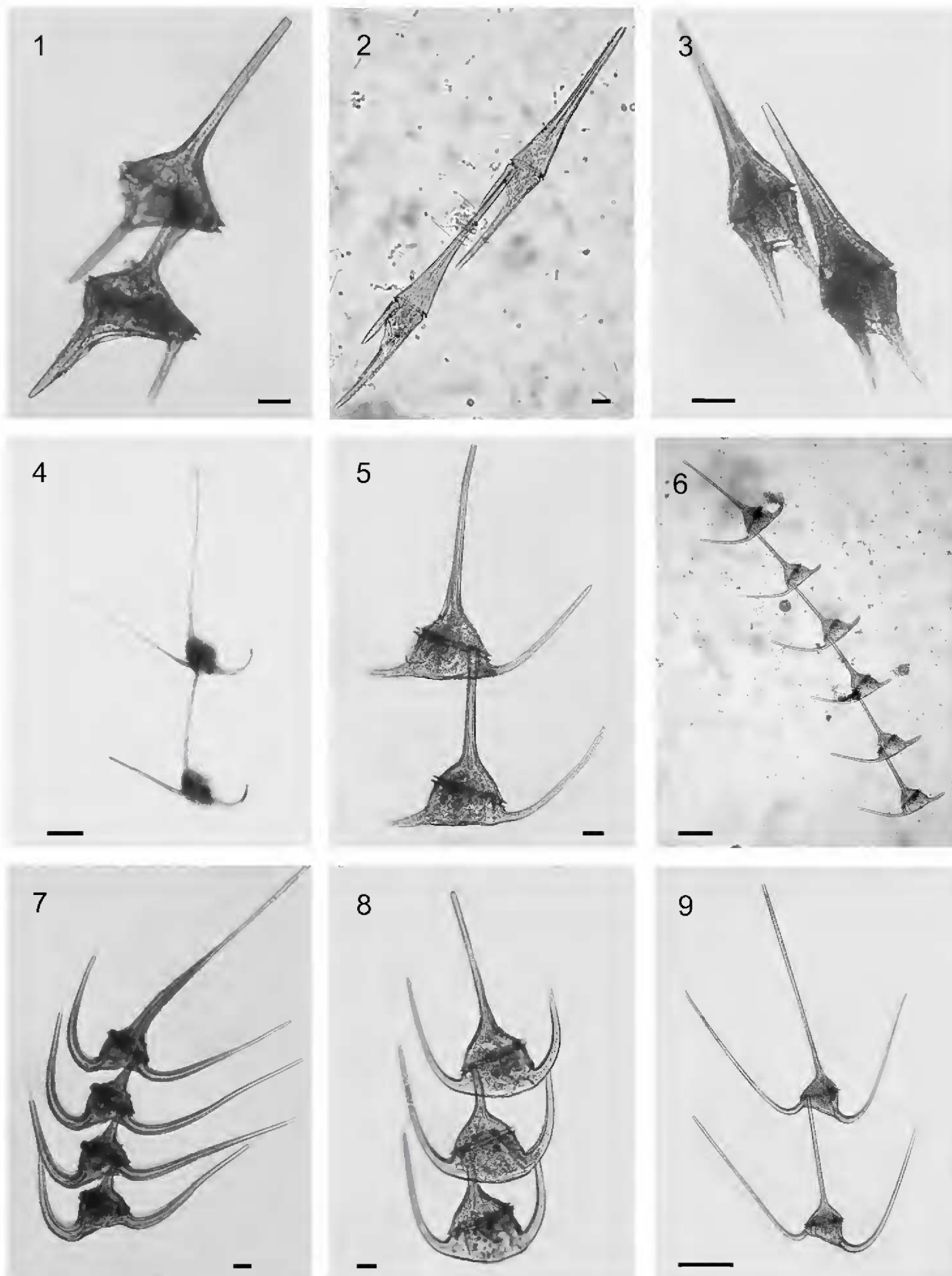


Plate 9. Colonies of *Ceratium* species. Fig. 1. *C. candelabrum* (DV). Fig. 2. *C. furca* var. *furca* (VV). Fig. 3. *C. furca* var. *hircus* (VV). Fig. 4. *C. hexacanthum* (VV). Fig. 5 (DV) and 6 (VV). *C. dens*. Fig. 7. *C. vultur* f. *vultur* (DV). Fig. 8. *C. tripos* (VV). Fig. 9. *C. massiliense* var. *armatum* (VV). Scale bars: 20 μm in Fig. 1-3, 5, 7 and 8; 100 μm in Fig. 4, 6 and 9.

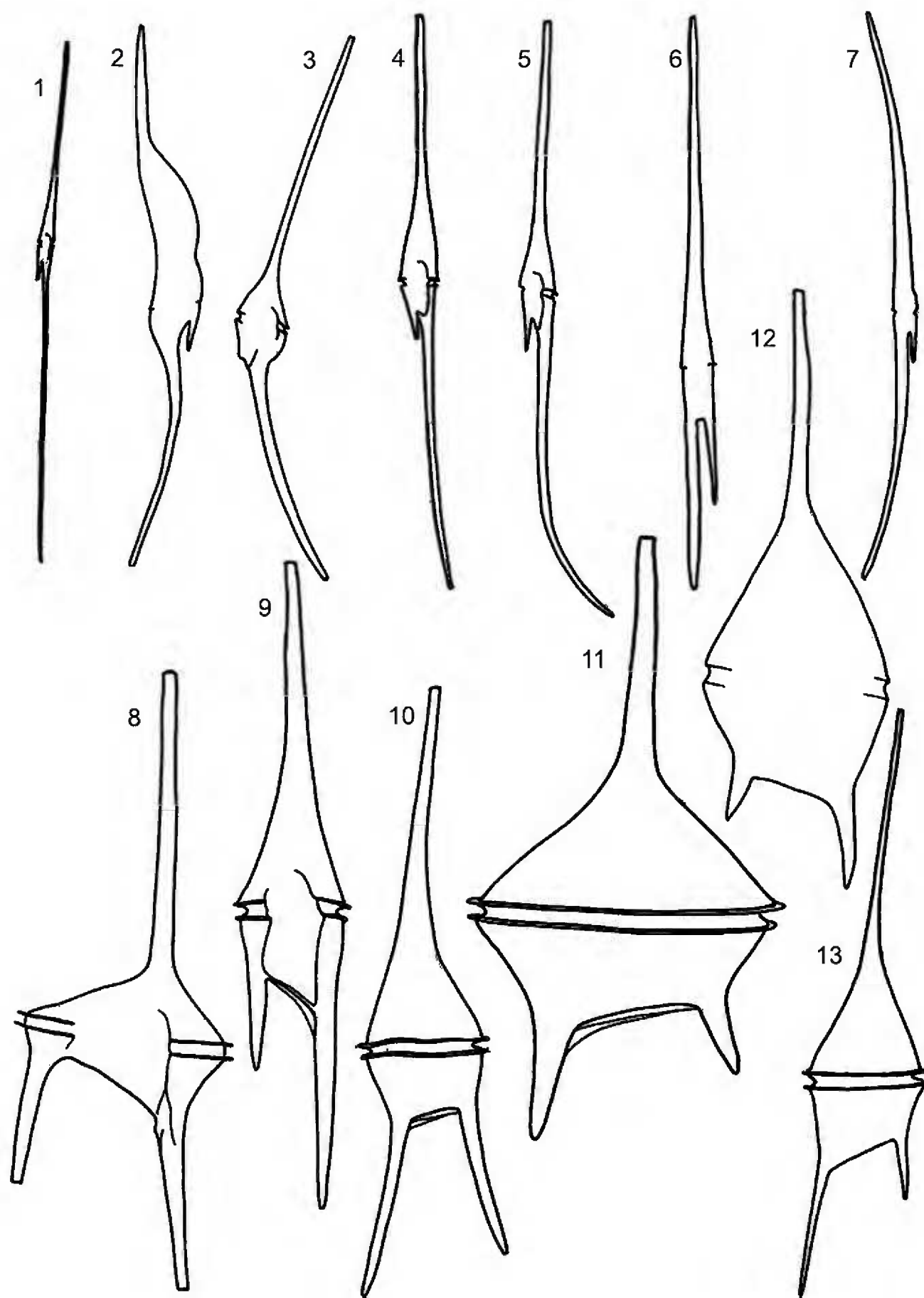


Plate 10. Fig. 1. *Ceratium extensum*. Fig. 2. *C. geniculatum*. Fig. 3. *C. bigelowii*. Fig. 4. *C. fusus*. Fig. 5. *C. inflatum*. Fig. 6. *C. belone*. Fig. 7. *C. longirostrum*. Fig. 8. *C. candelabrum*. Fig. 9. *C. furca* var. *furca*. Fig. 10. *C. furca* var. *hircus*. Fig. 11. *C. pentagonum* var. *tenerum*. Fig. 12. *C. teres*. Fig. 13. *C. kofoidii*.

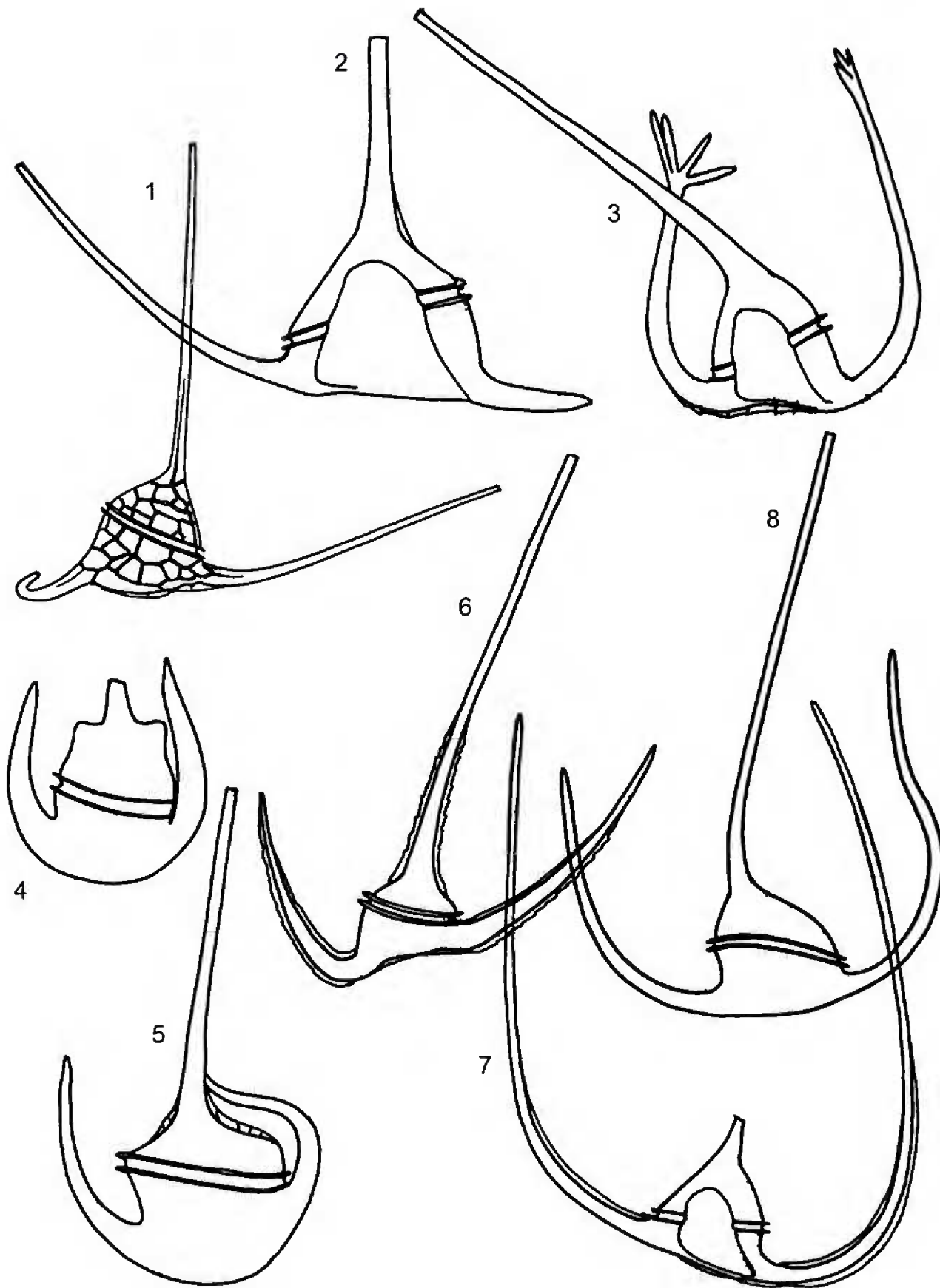


Plate 11. Fig. 1. *Ceratium hexacanthum*. Fig. 2. *C. dens*. Fig. 3. *C. ranipes*. Fig. 4. *C. limulus*. Fig. 5. *C. gibberum* var. *dispar*. Fig. 6. *C. vultur* f. *vultur*. Fig. 7. *C. lunula*. Fig. 8. *C. contortum* var. *contortum*.

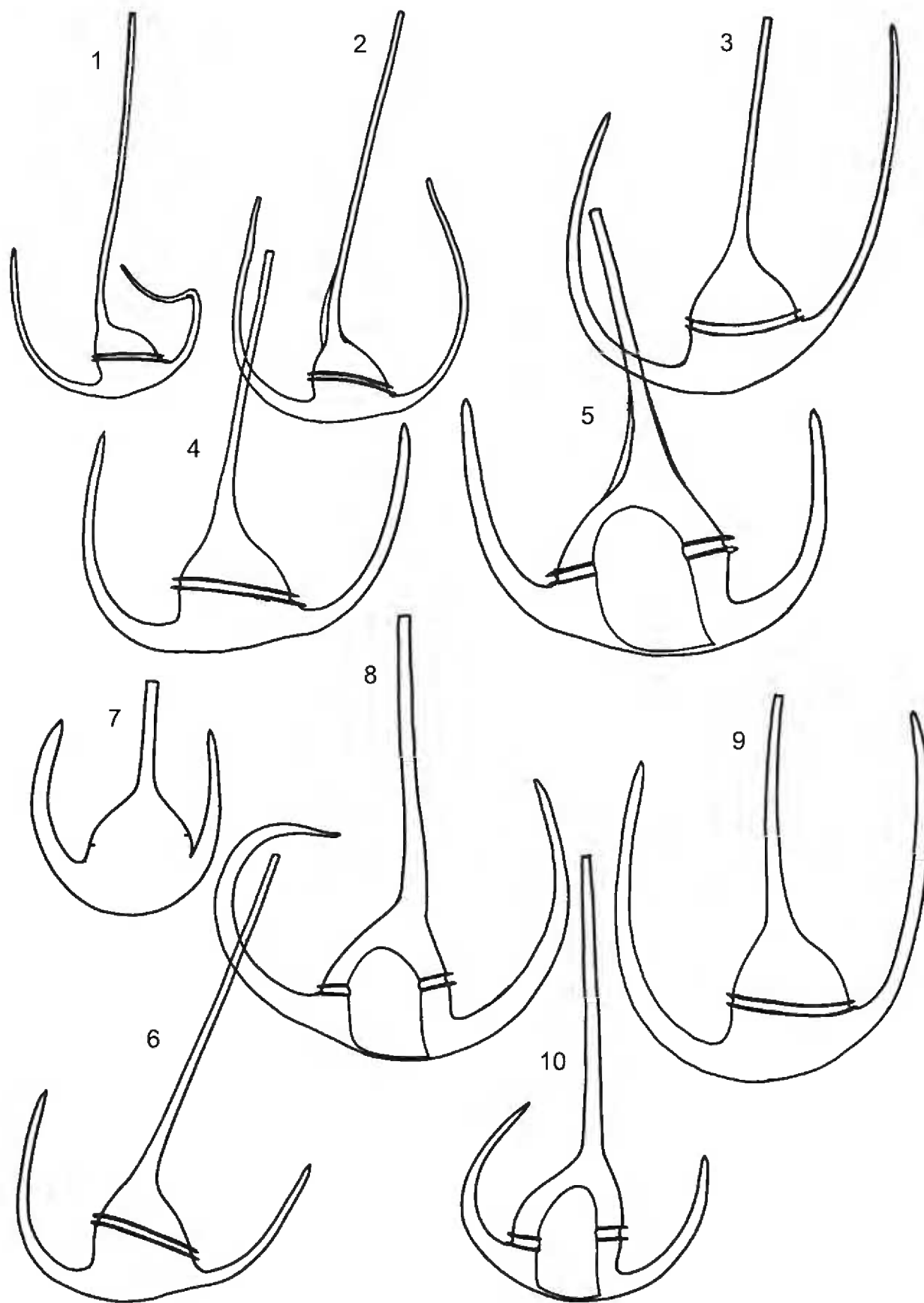


Plate 12. Fig. 1. *Ceratium contortum* var. *saltans*. Fig. 2. *C. karstenii*. Fig. 3. *C. euarcuratum*. Fig. 4. *C. tripos* var. *tripos*. Fig. 5. *C. tripos* var. *breve*. Fig. 6. *C. tripos* f. *tripodoides*. Fig. 7. *C. azoricum*. Fig. 8. *C. arietinum* var. *gracilentum*. Fig. 9. *C. symmetricum*. Fig. 10. *C. declinatum* var. *angusticornum*.



Plate 13. Fig. 1. *Ceratium declinatum* f. *normale*. Fig. 2. *C. carriense*. Fig. 3. *C. macroceros* var. *gallicum*. Fig. 4. *C. horridum* var. *molle*. Fig. 5. *C. horridum* var. *buceros*. Fig. 6. *C. massiliense* var. *armatum*. Fig. 7. *C. contrarium*. Fig. 8. *C. trichoceros*.